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ABSTRACT

The report summarizes findings from an examination of the physical fitness of orthopedically and sensory impaired students (10-17 years old). Physical fitness was hypothesized to include six areas: body composition, muscular strength/endurance, speed, agility, flexibility, and cardiorespiratory endurance. A chapter on methods details subject selection procedures (including information of definitions, categories, and codes) and tests for each of the six areas. Ss' scores are presented for each test item, at each age, for males and females, and for sexes combined. The effects of groups/conditions, age, and sex on physical fitness test performance are analyzed, as are the effects of severity and onset of handicapping condition and methods of ambulation. Also presented is descriptive information contrasting performance of nonhandicapped and handicapped Ss. Factor structures of fitness for specific groups are provided. Curricular implications of the study's results pertain to the commonality of factor structure, levels of physical fitness, type and severity of handicapping condition, age, sex differences, educational setting, individualization, education responsibility, and training materials. (CL)

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THE PHYSICAL FITNESS OF SENSORY AND ORTHOPEDICALLY IMPAIRED YOUTH

by
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Project UNIQUE
Final Report, November, 1982

- - -

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THE PHYSICAL FITNESS OF SENSORY

AND ORTHOPEDICALLY IMPAIRED YOUTH

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Preface

In 1979, the State University of New York, College at Brockport was awarded a grant from the Office of Special Education and Rehabilitative Services (presently Special Education Programs), Department of Education, Washington, D.C., to study the fitness of sensory and orthopedically impaired children and youth. During the next three years, the objectives of the project were accomplished through a variety of activities and with the help of many individuals. The material that is presented in this report is a culmination of the activities of the project.

The impetus for this project may be traced back to Public Law 94-142, which specifies that all handicapped children must be made available a free, appropriate public education which emphasizes special education and related services to meet their unique need. The law clearly states that physical education must be made available to meet the unique needs of the handicapped. This project was designed to help professionals identify the unique physical fitness needs of individuals classified as sensory or orthopedically impaired. The study was based on the assumption that to determine a unique need, it is necessary to have a point of reference, and that this point of reference should be normal performance, whenever appropriate; the performance of other children and youth of the same sex, age, and disability, at certain times; and one's own performance at various points in time, as appropriate. In certain cases, it was recognized that all of these references could be used in the identification and/or justification of a unique need. If these are, indeed, the references for unique needs, it is necessary to provide baseline data relative to the physical fitness performance of these references, as appropriate. This, then, became the major focus of Project UNIQUE.

Prior to this study, relatively little research pertaining to the physical fitness of individuals with auditory impairments had been conducted. In regard to individuals with visual impairments, the most notable research was conducted by Buell in the 1950's. Little or no information was available in regard to the quantitative physical fitness abilities of youth with orthopedic disabilities. Tests to measure physical fitness factors were notably absent for these persons. The fact that little research had been conducted relative to individuals with orthopedic disabilities was not entirely by accident or total neglect. The diverse nature of various orthopedic conditions, the limitations placed on them, the wide variation in abilities, the complexities involved in conducting such research, concerns about the worthiness of quantitatively derived data, and philosophical beliefs about treatment and development all influenced the pursuit of, or lack of pursuit of, research in this area. These factors were obstacles which had to be dealt with in planning and conducting this present investigation.

Many of the problems associated with conducting this project were conceptual in nature. It was extremely difficult to group subjects in a way that would be relevant to physical fitness performance. After considerable thought, analysis, and debate, a decision was made to closely follow subclassifications recently developed by sport organizations, particularly the National Association of Sports for Cerebral Palsy and the National Wheelchair Athletic Association.

In selecting subjects for the study, it was necessary to eliminate individuals with multi-handicapping conditions. To do otherwise would have compounded

the results. This made it very difficult to attain a large number of subjects for the study. The fact that the study was concerned with relatively low incidence handicapping conditions meant that subjects were not generally available in high numbers in integrated settings. Instead, they were dispersed throughout broad geographical areas. Further, the availability of subjects was affected by mainstreaming. Instead of being able to obtain large numbers of eligible subjects at institutions, it was necessary to test a small number of subjects in many settings. These and other limiting factors limited subject numbers.

To the extreme satisfaction of the project staff, youngsters themselves enjoyed being subjects in the study. Even their teachers were amazed to find that youngsters of all groups were eager to take tests and to perform to the best of their abilities. When this was realized, it gave an added impetus to the investigators in regard to the importance of this study. It was clear that youngsters, whether normal or victims of some handicapping conditions, wanted to know their abilities and wanted to know how they compared with others. They also were interested in knowing how to improve their performance.

The principal researchers of this study needed to depend heavily on others for data collection. The central staff at Brockport trained coordinators and field testers in order to help collect data. More than 225 individuals, in over 150 schools and institutions, situated in 23 states plus the District of Columbia, collected data for this study. Fortunately, this study had many contributors (they are listed in the acknowledgement section). Without the help of those individuals, there is no way that this study could have been completed. Some persons gave extraordinary assistance. These included: Claudine Sherrill, Texas Woman's University; Leslie Anido, San Jose, California; Diane Lewandowski, Chicago Public Schools; Pat Kaylor, Adelphi University; Garth Tymeson, Northern Illinois University; Marty Williams and Karen Williams, Texas Woman's University; Michael Paciorek, Eastern Michigan University; Matt Sullivan, St. Louis County; Sandy Day, Hawkins and Associates, Inc., Washington, D.C.; Pat Lamb, Wisconsin School for the Deaf; Janice Fruge', Louisiana Department of Education; David Grove, Fairfax (Virginia) Public Schools; Troy Haydon, Tennessee School for the Deaf; Joy Krebs, Human Resources School, Albertson, New York; and Cam Kerst, Tacoma Public Schools.

This study would not have been conducted without Melville Appell, the first Project Officer. Without Mel's help, this project would never have gotten off the ground. Thanks must also be extended to Dr. Julian Stein. While at AAHPERD, Dr. Stein made several contributions to the project. Dr. Stein served as a resource for the conceptualization of the project. When the project was not ready for implementation, he said so loud and clear, and it was necessary to go back to the drawing board several times. Because of his professional involvement, this project is much better than it would have otherwise been.

The most important contributions to the project were made by the central staff at Brockport. Specifically, thanks have to be given to graduate assistants: Sue Fetzner, 1979-80; Joseph Kelly, 1980-81; and Scott Conners, 1981-82. Each of these individuals contributed much more than normally expected of a graduate assistant. Other graduate assistants in Special Physical Education also made tremendous contributions to the success of the project.

Barry Shultz, serving as chief statistical consultant, also was of tremendous value to the project. Finally, thanks has to be given to Deborah Shuster, whose outstanding skills as a secretary were of tremendous importance in attaining positive results in the project.

There is little question that this project was a team effort, including many, many individuals and institutions throughout the United States. In addition, it was a project in which individuals with handicapping conditions contributed much. To all of these individuals and institutions, very deep appreciation is extended.

Joseph P. Winnick, Project Director

Francis X. Short, Project Coordinator

ACKNOWLEDGEMENTS

This project was conducted via a professional team effort including the Project UNIQUE central staff at the State University of New York, College at Brockport; U.S. Department of Education; the project advisory board; professional organizations; various consultants; area coordinators; local coordinators; and field testers. The project could not have been completed without the cooperation of many schools and agencies throughout the United States. Throughout the project, it was clear that the individuals and institutions involved offered their help and cooperation because it was their hope that the results of the project would enhance the education of sensory and orthopedically impaired youth. To these individuals and institutions, very deep appreciation is extended.

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Claudine Sherrill - Texas Woman's University

Special Commendations

This project could not have been successful without the help of many dedicated persons including several who made extraordinary efforts on behalf of the project. Individuals who made extraordinary efforts include: Claudine Sherrill, Marty Williams, and Karen Williams, Texas Woman's University; Leslie Anido, San Jose, California; Diane Lewandowski, Chicago Public Schools; Pat Kaylor, Adelphi University; Garth Tymeson, Northern Illinois University; Michael Paciorek, Eastern Michigan University; Matt Sullivan, St. Louis County; Sandy Day, Hawkins and Associates, Inc., Washington, D.C.; Pat Lamb, Wisconsin School for the Deaf; Janice Fruge', Louisiana State Department of Education; David Grove, Fairfax County (Virginia) Public Schools; Troy Haydon, Tennessee School for the Deaf; Joy Krebs, Human Resources School, Albertson, New York; and Cam Kerst, Tacoma Public Schools. Melville Appell, the first project officer, and Julian Stein must also be credited with important impacts on the project.

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National Association of Sports for Cerebral Palsy

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Testing Sites

California State School for the Deaf, Riverside, California
Blackford High School, San Jose, California
Rogers Middle School, San Jose, California
Chandler Tripp School, San Jose, California
Monroe Elementary School, San Jose, California
Fremont School for the Deaf, Fremont, California
Bernal Intermediate School, San Jose, California
Washington School, Redondo, California
Kennedy High School, Fremont, California
Santa Clara County Office of Education, San Jose, California
Norseman Elementary School, Fresno, California
Iona Olson Elementary School, Marina, California
Los Orobles Junior High School, Marina, California
Tokay High School, Lodi, California
Lodi High School, Lodi, California
George Patton Elementary School, Fort Ord, California
Marshall Elementary School, Fort Ord, California
J. C. Crumpton Elementary School, Marina, California
Walter Culton Junior High School, Monterey, California
Marina Del Mar Elementary School, Marina, California
Wolters Elementary School, Fresno, California
Hoover High School, Fresno, California
Alwahnee Junior High School, Fresno, California

Model Secondary School at Gallaudet College, Washington, D.C.
Kendall Demonstration Elementary School for the Deaf, Washington, D.C.

Horace Mann Junior High School, Miami, Florida
Arcola Lake Elementary, Miami, Florida
Biscayn Gardens Elementary School, Miami, Florida
Tropical Elementary School, Miami, Florida

Georgia Academy for the Blind, Macon, Georgia

Idaho State School for the Deaf and Blind, Gooding, Idaho
Jenifer Junior High School, Lewiston, Idaho

Mahalia Jackson School, Chicago, Illinois
Reinberg School, Chicago, Illinois
Nathan Hale School, Chicago, Illinois
Ray Elementary School. Chicago, Illinois
Shields Elementary School, Chicago, Illinois
Whitney Young High School, Chicago, Illinois
Mark Skinner School, Chicago, Illinois
Lake View High School, Chicago, Illinois
Farnsworth School, Chicago, Illinois
Lincoln Elementary School, Chicago, Illinois
Beidler School, Chicago, Illinois
Hanson Park School, Chicago, Illinois
Spalding High School, Chicago, Illinois
James Ward Elementary School, Chicago, Illinois

Louisiana School for the Deaf, Baton Rouge, Louisiana
Patterson Junior High School, Patterson, Louisiana
Shannon Elementary School, Morgan City, Louisiana
Crowell Elementary School, Franklin, Louisiana
Louisiana School for the Visually Impaired, Baton Rouge, Louisiana
Valley Park Middle School, Baton Rouge, Louisiana
Children's Hospital, New Orleans, Louisiana
J.V. Fairchild Junior High School, Jefferson, Louisiana
New Orleans Mental Health Center, New Orleans, Louisiana
Patterson Senior High School, Patterson, Louisiana
Bayou Vista Elementary School, Morgan City, Louisiana
Mohican School, Baton Rouge, Louisiana
Louisiana Special Education Center, Alexandria, Louisiana
Caddo Exceptional, Shreveport, Louisiana

St. Louis Park Public School, St. Louis Park, Minnesota
Courage Center, Golden Valley, Minnesota
Minnesota Braille and Sight Saving School, Faribault, Minnesota
Como Special School, St. Paul, Minnesota

Missouri School for the Blind, St. Louis, Missouri
Special School District, St. Louis County, Town and Country, Missouri

Lincoln Public Schools, Lincoln, Nebraska

Gibson Junior High, Las Vegas, Nevada
Western High School, Las Vegas, Nevada

Camp Marcella, Verona, New Jersey
Bruce Street School, Newark, New Jersey
Helen Keller School, Newark, New Jersey
Branch Brook School, Newark, New Jersey

New Mexico School for the Visually Impaired, Alamogordo, New Mexico

St. Mary's School for the Deaf, Buffalo, New York
Rochester School for the Deaf, Rochester, New York
New York State School for the Blind, Batavia, New York
Brockport Middle School, Brockport, New York
Jefferson High School, Rochester, New York
Kendall Central Schools, Kendall, New York
New York State School for the Deaf, Rome, New York
Hilton Central Schools, Hilton, New York
Albion High School, Albion, New York
Albion Middle School, Albion, New York
Human Resources School, Albertson, New York
New York Institute for the Education of the Blind, Bronx, New York
Rush-Henrietta Central School District, Henrietta, New York
School No. 29, Rochester, New York
John H. West Elementary School, Plainedge, New York
Herricks Middle School, New Hyde Park, New York
Albany Center for the Disabled, Albany, New York
Lexington School for the Deaf, Jackson Heights, New York
St. Joseph's School for the Deaf, Bronx, New York
Al Sigl Center for Rehabilitative Agencies, Rochester, New York
Fairport Central School, Fairport, New York

Columbus Public Schools, Columbus, Ohio
Ohio State School for the Blind, Columbus, Ohio
Sunbeam School, Cleveland, Ohio

Parkview School for the Blind, Muskogee, Oklahoma
Oklahoma School for the Deaf, Sulphur, Oklahoma

Overbrook School for the Blind, Philadelphia, Pennsylvania
Liberty Elementary School, Pittsburgh, Pennsylvania
Beechwood Elementary School, Pittsburgh, Pennsylvania
Riezenstein Middle School, Pittsburgh, Pennsylvania
Allegheny Valley School, Pittsburgh, Pennsylvania
Pioneer Center, Pittsburgh, Pennsylvania
John Morrow Elementary, Pittsburgh, Pennsylvania
Regent Square Elementary School, Pittsburgh, Pennsylvania
Widener Memorial School, Philadelphia, Pennsylvania

Crippled Children's Hospital, Sioux Falls, South Dakota
South Dakota School for the Deaf, Sioux Falls, South Dakota
South Dakota School for the Visually Handicapped, Aberdeen, South Dakota

Tennessee School for the Deaf, Knoxville, Tennessee
Tennessee School for the Blind, Nashville, Tennessee

Bruce Shulkey Elementary School, Fort Worth, Texas
Texas School for the Deaf, Austin, Texas
Preston Hollow Day School, Dallas, Texas
Texas School for the Blind, Austin, Texas
Grady Special School, Houston, Texas
Denton High School, Denton, Texas
Brownsville Regional School for the Deaf, Brownsville, Texas
Congress Junior High School, Denton, Texas
Rogers Elementary School, Houston, Texas
Lockhart Elementary School, Houston, Texas
Milby Senior High School, Houston, Texas
Edison Junior High School, Houston, Texas
Welch Middle School, Houston, Texas
Kate Bell Elementary School, Houston, Texas
Holland Middle School, Houston, Texas
Tijerina Elementary School, Houston, Texas
Alief Yovens Elementary School, Alief, Texas
Don P. Killough Middle School, Alief, Texas
Pershing Middle School, Houston, Texas
Elsik High School, Alief, Texas
Westbury, Houston, Texas
Olle Middle School, Alief, Texas
A.J. Martin Elementary School, Alief, Texas
Cimmeron School, Galena Park, Texas
Landrum Junior High School, Spring Branch, Texas
Spring Branch High School, Spring Branch, Texas
Chancellor Elementary School, Alief, Texas
Sharpstown School, Houston, Texas

Utah School for the Deaf, Ogden, Utah

Fairfax County Public Schools, Fairfax, Virginia
Virginia School for the Deaf and Blind, Hampton, Virginia
White Oaks Elementary School, Burke, Virginia

Jason Lee Junior High School, Tacoma, Washington
Truman Junior High School, Tacoma, Washington
Birney Elementary School, Tacoma, Washington
Seward Elementary School, Tacoma, Washington
Stadium High School, Tacoma, Washington
Skyline Elementary School, Tacoma, Washington
Hunt Junior High School, Tacoma, Washington

21st Street Elementary School, Milwaukee, Wisconsin
Webster Middle School, Milwaukee, Wisconsin
Cass Street Elementary School, Milwaukee, Wisconsin
Marshall High School, Milwaukee, Wisconsin
Emerson Elementary School, Milwaukee, Wisconsin
Gaenslen School, Milwaukee, Wisconsin
Manitoba, Milwaukee, Wisconsin
Silver Spring Elementary School, Milwaukee, Wisconsin
Stewart Elementary School, Milwaukee, Wisconsin
Lake Buff Elementary School, Shorewood, Wisconsin
University of Wisconsin, La Crosse, Wisconsin
Wisconsin School for the Deaf, Delavan, Wisconsin
Wisconsin School for the Visually Impaired, Janesville, Wisconsin

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CHAPTER I

INTRODUCTION

Background

The positive value of physical fitness is widely accepted in the United States today. Physical fitness is important for enhancing the quality and length of life and is important in the play and development of children and youth.

Although physical fitness is important for all persons, it is particularly important for children and youth with sensory or orthopedic impairments. In regard to persons with visual impairments, the importance of physical activity has been recognized for many years. Physical activity has been advocated for persons with visual handicaps, particularly in residential school programs throughout the country for over a century. Educators of the blind have long felt that the blind need greater than average stamina if they are to effectively cope in society. Physical fitness is important for persons with visual impairments so that they may move effectively through the environment.

Because of communicative difficulties and accompanying tendency to withdraw, it is not uncommon for the physical fitness status of persons with auditory impairments to be below normal. Since this is the case, it is important to arrange and carefully plan physical development for these persons. When this is done, there is no reason why an individual with an auditory handicap cannot be as successful as non-impaired persons in physical development.

For the orthopedic impaired, the values of physical fitness are profound. Individuals with congenital anomalies or amputations must not only develop non-impaired body parts, but also must seek to develop, to the optimal level, affected parts of the body. Individuals with spinal neuromuscular conditions need to maintain and develop their physical fitness to engage in physical activity pursuits and develop and maintain a healthy body. All persons with orthopedic impairments desperately require activities to overcome atrophy, contractures, and possible deformities. They may, in fact, need higher levels of fitness for compensatory behaviors, i.e., to facilitate ambulation. Therefore, physical fitness is often a primary concern in their educational program. Although physical fitness is important for these individuals for health and physical performance, it is also important for social and emotional development. Where necessary physical fitness levels are attained, these individuals are likely to participate in play and sport activities and receive the same physical and social benefits from these activities as non-impaired children and youth.

Although it is clear that physical fitness is at least as, if not more, important to the sensory and orthopedic impaired as the non-impaired, less attention has been given to fitness related programs for these individuals. In some situations, they are absolutely neglected in instructional physical education programs, intramurals, and athletic programs. According to law, the handicapped have an equal opportunity to attain the same benefits from these programs as normal individuals. With the passage of PL 94-142 and Section 504 of the Rehabilitation Act of 1973, an impetus for change has been provided. However, legislation is not enough.

If the sensory and orthopedic impaired are to develop the physical fitness necessary to pursue careers, participate in intramural and athletic activities, or to enjoy the quality of life to which they are entitled, they need quality individualized education programs. To effectively implement quality programs for these individuals, teachers and program leaders must have knowledge and skills to assess performance, determine unique needs, set objectives and goals to improve performance, and implement and evaluate quality programs. Information is needed about the physical fitness abilities of these groups. There is a need to know what abilities may be improved, their rate and sequence of development, how they may be improved, how they may be measured, and the factors which affect performance. Valid and reliable instruments to measure the components of physical fitness, which are relevant and appropriate for these groups, must be developed and used. Teachers and program leaders must recognize differences, the implications that differences suggest in implementing programs, and the need to make allowances for individuals who may be different.

A review of research indicates that very little normative data is available in regard to the physical performance of the visually impaired. Buell (1966, 1973) developed physical fitness tests designed for individuals with visual handicaps by adapting the AAHPER Youth Fitness Test, the AAU Physical Fitness Test, and the California Minimal Performance Test. Subsequently, Buell developed adjusted norms for blind and partially sighted boys and girls on the 50-yard dash, the 600-yard run/walk, and proposed substitutions for some of the other items on these particular tests. In his doctoral dissertation, Buell (1950) developed standards of achievement for children and youth with visual handicaps in selected areas of athletic performance.

Although there is a paucity of research in which the performance of youngsters with visual handicaps is compared with normally sighted youngsters, it has been generally found, and there is an agreement amongst writers, that children and youth with visually handicapping conditions are poorer in physical fitness measures than their normally sighted peers, the scores of partially sighted youngsters exceed those of totally blind youngsters, and the performance of visually impaired boys exceeds that of visually impaired girls (Buell, 1966, 1973; Winnick, 1979). According to descriptive data, visually handicapped girls improve in physical proficiency between the ages of six and 13 or 14, but appear to plateau between the ages of 13 or 14 and 17 (Winnick, 1979). Based on data collected by Buell (1966, 1973), visually handicapped boys, on the other hand, show consistent improvement in performance between the ages of six and 17 (Winnick, 1979).

Available research also indicates that the performance of youngsters with visual handicapping conditions is affected by physical education experiences and opportunities for movement. Buell (1950b) found that motor performance of youngsters with visual handicapping conditions was affected by the physical education they received in school and elsewhere. The importance of opportunity for movement or mobility for motoric development was supported by a study by Norris, Spalding, and Brodie (1957).

In regard to the onset and duration of blindness, Buell (1950a, 1950b) reported that children who lose their vision after six years of age do not have as much difficulty in developing physical abilities as do children blind from

early childhood. He found that recently blinded girls performed better in running, throwing, and jumping than those afflicted earlier, and that boys losing their vision after six years of age threw a basketball farther than the blind who had never seen a throw.

On the basis of his review of the research, Winnick (1979) found that the relative performance of youngsters with visual handicapping conditions, in measures of physical proficiency, varies with the type of activity performed. He noted that blind youngsters have particular difficulty in activities which involve throwing, since they have not seen the activity performed correctly. It follows that differences on throw-type fitness items may be due more to coordination and learning than to real differences in physical fitness. Winnick (1979) also points out that high scores in activities involving running are particularly difficult to attain by blind youngsters because performance is restricted by the need to maintain contact with guide wires, performing with a partner, or being guided by auditory or tactual cues. The blind come nearer to the performance of the normally sighted in uncomplicated activities performed in place, such as the flexed arm hang, sit-ups, pull-ups, and the standing broad jump (Winnick, 1979). When youngsters with visual handicapping conditions perform below normal standards in these events, real differences in physical fitness are more likely to exist, and these differences are invariably influenced by participation in physical activity (Winnick, 1979).

Although the physical and motor performance of the normally sighted exceeds that of youngsters impaired visually, comparisons reveal that differences between these groups decrease with increases in age. For example, differences in broad jumping, running speed, and long distance running at ages six to seven decreases as youngsters approach and attain age 17 (Winnick, 1979). In fact, Buell (1950a) found that high school boys with visual impairments exceeded mean scores of normally sighted high school boys in the standing broad jump. He attributed this result to greater familiarity and practice of the task by youngsters with visual impairments.

In regard to the deaf, the ability to balance has received the most attention of researchers studying their physical and motor status. In one of the earliest studies evaluating the motor abilities of deaf children, Long (1932) found that the performance of hearing subjects in walking a balance beam was significantly superior to that of deaf subjects aged eight to 17 with whom they were paired. In another study, Morsh (1936) found that, when blindfolded, deaf subjects showed inferior balancing performance to that of blindfolded hearing subjects. In a more comprehensive study, Myklebust (1964) tested and compared the performance of deaf and hearing subjects on the railwalking test and again found that deaf children were inferior to the hearing. In addition, the deaf were found to progress in ability with age, but the hearing maintained their superiority throughout the age ranges studied. In the same study, Myklebust studied railwalking performance as a function of etiology and found no significant differences between the acquired, congenital, and undetermined groups. However, the meningetic were significantly inferior to each of the other three groups. Myklebust found that the poor performance by the group with meningitis could be explained by the malfunctioning of semicircular canals--a condition frequently associated with this disease. On the basis of research which has been completed, it appears fair to conclude that the deaf, as a group, are inferior to the hearing on static and dynamic balance, particularly

in areas where semicircular canal dysfunction exists. However, implications should be drawn with extreme caution since there is much clinical evidence indicating that the deaf can achieve high degrees of performance in balance-oriented activities and, in many cases, balance has not been found to be an inhibiting factor in performance.

As is true with other physical and motor areas, relatively little research has been completed relative to motor maturation or the development of locomotor abilities of the deaf. Myklebust (1954) conducted a study in which the sitting and walking ages for normal, aphasic, emotionally disturbed, mentally retarded, and deaf subjects were compared. Differences between the deaf and hearing were not significant. Frisina (1955) found that mentally retarded deaf children were significantly inferior to normal deaf children in age of sitting and walking. In view of these findings, it may be necessary that mental age be controlled when between group comparisons of motor maturation are made.

Winnick (1979) states that clinical data and other observations of the performance of the deaf have lead professionals to attribute other physical and motor characteristics to the deaf. Some writers have indicated that the deaf are underdeveloped physically because of their tendency to withdraw from play activities and games and sports requiring communication. Myklebust (1964) stated that persons with severe hearing losses tend to walk with a shuffling gait. Since this characteristic is not limited to those with semi-circular dysfunctioning, Myklebust assumes it is due to the inability of the deaf to hear movement sounds, i.e., their feet shuffling as they walk. Arnheim, Auxter, and Crowe (1969) stated that deaf children have poor body mechanics and poor patterns of locomotion. Fait (1972) assets that movement of the deaf may be poorly coordinated, purposeless, vague, and distorted because of the loss of background sounds for orientation and accuracy in the recognition of space and motion.

Although some studies have been conducted to determine the effects of physical training on the physical fitness factors of certain types of individuals with orthopedic impairments, little or no information is available in regard to the quantitative physical fitness abilities of orthopedically impaired children and youth. Also, tests to measure factors related to physical fitness development have been notably absent. Typically, physical performance has been assessed using qualitatively oriented assessment devices which have been developed by physical or occupational therapists. Although Vodola (1978) has developed a four-item physical fitness test which may be used with ambulatory retarded children, no norms were given for ambulatory retarded children in conjunction with the test. The fact that little research has been conducted is not entirely by accident or total neglect. The nature of various orthopedic conditions, the limitations placed on individuals, the wide variation in abilities, the complexities involved in conducting such research, concerns about the worthiness of quantitatively derived instruments, and philosophical beliefs about treatment and development have influenced the pursuit of research in this area.

PL 94-142 and the Unique Needs Concept

According to PL 94-142, all handicapped children must be provided a free, appropriate public education which emphasizes special education and related

services to meet their unique needs. The law defines the term special education as specially designed instruction, at no cost to parents or guardians, to meet the unique needs of the handicapped child, and includes classroom instruction, instruction in physical education, home instruction, and instruction in hospitals and institutions.

The law clearly states that physical education must be provided to meet the unique (as opposed to identical or same) needs of the handicapped. But what are needs? What constitutes a unique need?

It seems logical that to determine a unique need, one must select a point of reference. Just as speed of movement becomes meaningful when it is based on simultaneity and visual defects when related to normal vision, unique physical needs of individuals with handicapping conditions must be based upon a standard of reference. This reference may include the performance of non-impaired children and youth of the same sex, age, or grade level; the performance of other children and youth with the same age, sex, and disability; or one's own performance in various points in time. In certain instances, all of these references may be used in the identification of a unique need.

There is a need in the field for baseline data which can be utilized by professionals to determine unique needs and to plan and implement quality programs for the sensory and orthopedic impaired. Where possible, it is helpful to utilize quantifiable data so that the reference point is objective and clear, appropriate objectives can be clearly set, programs may be planned, and progress can be measured.

Focus of the Study

It should be clear, on the basis of the information which has been presented, that there is a need to increase knowledge concerning the physical fitness abilities of sensory and orthopedically impaired children and youth. Ultimately, this information is necessary so that program leaders may assess, compare, and improve performance. The intention of this study was to provide basic data which may be utilized by professionals to determine the unique needs of sensory and orthopedically impaired youngsters and to provide further information concerning factors which may influence the development of the physical fitness of these populations. Data generated from this study will provide basic information to compare individuals at various ages, data which may be used to compare the performance of impaired with normal populations, and data which will enable intra-individual comparisons. The study provides data relative to the factor structure of physical abilities of the sensory and orthopedic impaired, baseline data which might be used to identify curricular emphases with these populations, data which will provide age and sex comparisons, data which will serve as a basis for studying the relationship between onset of conditions and physical performance, and data which will contribute to an understanding of degree of handicapping conditions and performance. Finally, from the results of study, a valid and reliable test of physical fitness for impaired groups under consideration was developed and, hopefully, will be used to assess present levels of performance, compare performance, and identify unique needs. The study was delimited to include orthopedic and sensory impaired youngsters between the ages of 10 and 17.

Objectives

More specifically, the objectives of this study were:

1. To provide descriptive data of the physical performance of orthopedically and sensory impaired boys and girls between the ages of 10 and 17.

2. To compare the physical fitness of orthopedically and sensory impaired samples with each other and with normal boys and girls of the same sex and age.

3. To identify, analyze, and compare age trends of the physical development of normal, orthopedically, and sensory impaired boys and girls.

4. To analyze the effects of onset of handicapping conditions, physical education experiences, activity history, and geographic influences on the physical fitness of orthopedically and sensory impaired boys and girls.

5. To determine sex influences on the physical fitness of orthopedically and sensory impaired boys and girls.

6. To determine the factor structure of physical abilities of orthopedically and sensory impaired boys and girls and to compare the factor structure with normal populations and with each other.

7. To identify curricular implications pertaining to physical fitness on the basis of measured physical fitness abilities of orthopedically and sensory impaired boys and girls.

8. To develop valid and reliable tests of physical fitness for the orthopedic and sensory impaired on the basis of data collected.

Hypothesized Factor Structure of Physical Fitness

The theoretical frame of reference for this study emerges from a particular conception of physical fitness which is supported by related factor analytic studies, the conceptions reflected in currently used field-based tests of physical fitness, and logical considerations.

For the purposes of this project, physical fitness was recognized as a part of the total fitness of the individual. Total fitness includes mental development, emotional development, social development, motor development, and physical development appropriate to the maturity of the individual. It also assumed that physical fitness implies freedom from disease, the ability to meet the physical requirements of daily tasks without undue fatigue, and the ability to withstand ordinary stresses of life without harmful strain. This concept of physical fitness enables the individual to carry out the requirements of daily living, to enjoy leisure time pursuits, and to meet unforeseen emergencies.

In agreement with previous work which has been done in relationship to physical fitness in field situations, this study recognized physical fitness as a multidimensional construct. This means that physical fitness was not considered as a generic concept, but was considered as an umbrella term for a

series of specific components. Thus, physical fitness was conceived of being incapable of being represented by a single measure, but consists of a series of specific abilities which, although related, to some extent, are discrete enough to warrant separate measurement.

This concept of physical fitness recognizes fitness as involving both a health related and a physical performance related component. It recognizes the importance of physical fitness for the optimum health of the individual and the physical fitness necessary to optimally perform tasks of daily living and physical and sport activities. In agreement with the AAHPERD Health Related Physical Fitness Test (1980), this concept of physical fitness recognizes cardiorespiratory function, body composition (leanness/fatness), and abdominal and low back hamstring musculoskeletal function as areas of physiological function which are related to positive health. This concept of fitness is also in agreement with physical fitness tests which are used to measure the physiological functional abilities which are necessary to perform tasks of daily living, certain occupational activities, and particularly, sport activities (performance related physical fitness). The AAHPER Youth Fitness Test (1976) was used as a reference point in selecting performance related components of fitness. Test modifications developed by Buell (1966, 1973) were considered in terms of components, test items, and modifications of test items which may be appropriate for visually impaired children and youth. Particular attention was given to these sources because it was assumed that the factor structure for the groups under study herein would be similar, if not the same, as those of normal and visually impaired populations. If this assumption was found to be correct, it would enhance comparative evaluations. These tests were developed with the assumption that components including muscular strength/endurance, speed, agility, cardiorespiratory function, body composition, and flexibility are components of physical fitness which influence performance.

The theoretical framework for this study was influenced by the results of related factor analytic studies of physical fitness using normal subjects (Fleishman, 1964a, 1964b), normal and educable mentally retarded (EMR) subjects (Rarick and Dobbins, 1972), and normal and trainable mentally retarded (TMR) subjects (Rarick and McQuillan, 1977). These studies were analyzed to help determine the hypothesized factor structure and test items to measure factors or components of physical fitness.

In selecting components for study, one additional factor was considered. Since it was felt that balance may be a factor in influencing participation in physical activities, particularly for the physically handicapped and possibly the auditory impaired, it was decided to administer a test of static balance in the study. However, it should be stressed that this was not conceived as a physical fitness component, but as a factor which might influence participation in physical fitness and, thereby, influence physical fitness status.

In essence, then, the theoretical frame of reference for this study was based on the belief that there are certain relatively well defined components of physical fitness which are needed for the purposes of developing optimal health and enhancing performance in daily activities, occupational activities, and sport performance. It was hypothesized that the basic components underlying health and performance related physical fitness should include muscular strength/endurance, cardiorespiratory endurance, a desirable level of fatness/leanness,

flexibility in certain areas of the body, speed of movement, and the ability to change directions (agility). The components of fitness, as well as the test items which were used in this study to measure the components, are listed below. It was believed that these components enhance the domain of physical fitness, as conceptualized in this study, and serve as a logical foundation for identifying the physical fitness components of normal, sensory impaired, and orthopedically impaired children and youth and for attaining the other objectives of the study.

1. Body Composition

   triceps skinfold
   subscapular skinfold
   abdominal skinfold

2. Muscular Strength/Endurance

   flexed knee sit-ups
   timed leg raise
   timed trunk raise
   grip strength
   flexed arm hang
   pull-ups
   standing broad jump
   softball throw (distance and/or velocity)

3. Speed

   50-yard dash
   50-meter dash

4. Agility

   rise-to-stand
   mat creep
   shuttle run

5. Flexibility

   sit and reach

6. Cardiorespiratory Endurance

   Ages 10-12: 1 mile or 9-minute run
   Ages 13-17: 1½ mile or 12-minute run

In addition to the hypothesized factor structure of physical fitness, a test item measuring static balance was incorporated in the study.

CHAPTER II

METHODS AND PROCEDURES

General Procedures

In this section, a brief overview of the procedures that were followed in this study is presented. The first step was the formulation of a hypothesized factor structure which embraced health and performance dimensions of physical fitness of normal and impaired children and youth between the ages of 10 and 17. The second step was to identify, define, and classify subject groups in a way which would be relevant to physical fitness performance. The third step was to select tests which would measure the various hypothesized factors of physical fitness and to modify these for individuals with handicapping conditions, as appropriate. The fourth step was to analyze items in terms of subject classifications to determine whether or not test items could be administered to a particular subgroup. In cases where subjects could not appropriately take a test, the items were eliminated for that particular subject group. Participation guides, matching test items and subject classifications, were developed so that testers would know which items should be administered or modified for a particular group or subgroup. The fifth step was to develop a testing network which could be employed for the testing of subjects throughout the United States. Once the network was established, the next step was to train personnel to administer tests, select subjects, record data, and transmit data to the SUNY, College at Brockport for analysis. Once the testing personnel were trained and certified to collect data, subjects were selected following standardized procedures and tests were administered. Following test administration, data were transferred from field data recording sheets to computerized scan sheets. After data were recorded on these forms, it was checked by the central staff of Project UNIQUE. The data, then, were analyzed by the project staff, and a final report, including a physical fitness test and a training program, was developed.

The time duration of the investigation was from June 1, 1979 to August 31, 1982. The actual collection of data extended from March 1980 to March 1982.

Geographical Areas

Subjects were selected from institutionalized and non-institutionalized settings located throughout five geographical areas of the United States, including the northeast, southeast, central, northwest, and southwest regions of the country (see Figure 2.1). Each of these regions included one or more coordinators who organized and administered training and testing in their geographical areas. Coordinators located testers in their region, conducted training programs, certified testers, recommended participating school districts and subjects for the study, coordinated testing schedules, and dispersed equipment, as needed. The states and territories encompassed within regions is presented below.

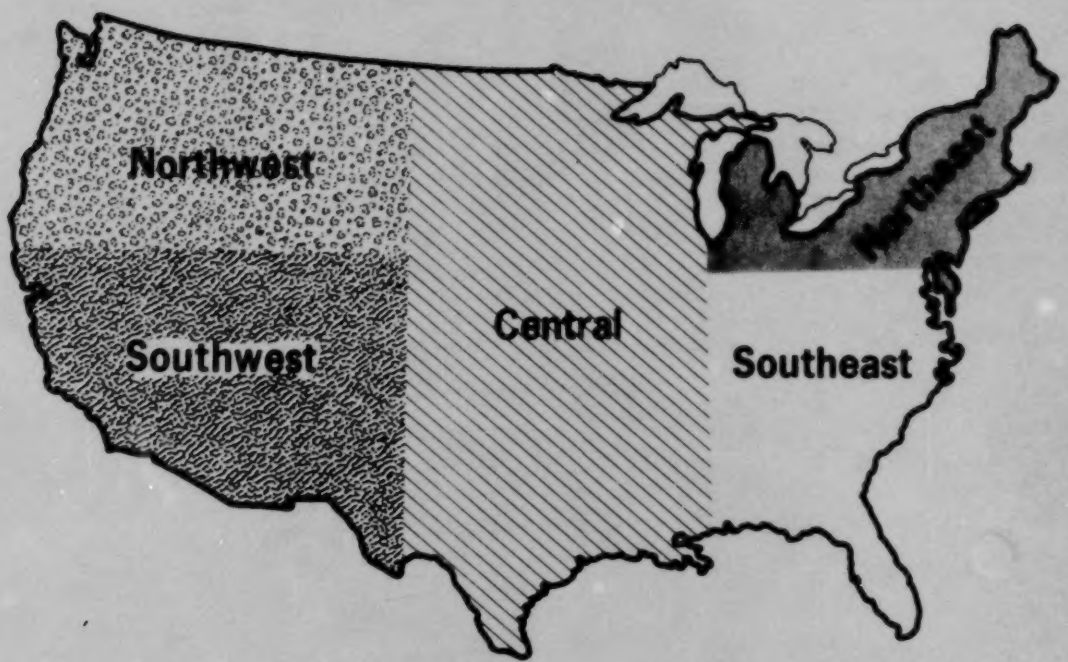

Figure 2.1 Project UNIQUE geographical coverage

Northeast	Southeast	Central	Northwest	Southwest
New York	Virgin Islands	Wisconsin	Washington	California
New Jersey	Maryland	Minnesota	Oregon	Arizona
Maine	Virginia	Texas	Idaho	New Mexico
New Hampshire	West Virginia	Illinois	Montana	Utah
Connecticut	North Carolina	Missouri	North Dakota	Colorado
Massachusetts	South Carolina	Arkansas	South Dakota	Nevada
Delaware	Georgia	Kansas	Wyoming	Hawaii
Pennsylvania	Florida	Mississippi	Alaska	Guam
Ohio	Alabama	Louisiana		
Michigan	Kentucky	Iowa		
Vermont	Tennessee	Nebraska		
Rhode Island	Puerto Rico	Indiana		
		Oklahoma		

Field Testers

Field testers were identified and trained by coordinators. Except where these functions were performed by central staff or coordinators, field testers served to identify subjects, attain permissions to test the subjects, administered tests to pupils in schools or institutional settings, recorded data on a data recording sheet, and transferred the data from the data recording sheet to a computerized scan sheet. All data were forwarded to Brockport for checking, computer preparation, and data analysis.

Field testers for the study consisted of individuals, mostly graduate students and teachers, who were certified as Project UNIQUE testers. Individuals certified as testers were required to complete a competency-based training program. To a great extent, teachers of physical education tested their own pupils.

Subject Selection

The subjects for this study came from states representing the five regions of the United States previously identified. Subjects were selected from four major categories: normal (non-impaired), the visually impaired, auditory impaired, and orthopedic impaired. A distribution of subjects by geographic region and handicapping condition is presented in Table 2.1. All subjects were between the ages of 10 through 17 and free of multiple handicapping conditions. Age was determined by the individual's age at the time the first test was administered.

TABLE 2.1. NUMBER OF SUBJECTS CATEGORIZED BY GEOGRAPHIC LOCATION, HANDICAPPING CONDITION, AND SEX.

	Northeast		Southeast		Central		Northwest		Southwest	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Normal	282	346	102	73	52	159	28	34	47	69
Visual Impairments	99	71	77	54	166	107	10	5	35	25
Auditory Impairments	228	192	156	121	273	215	39	26	127	91
Orthopedic Impairments	118	114	18	13	127	97	4	3	61	50

Selection of Normal Subjects

The sample of normal subjects was, to the extent possible, randomly selected from those schools which agreed to participate in the study. In most cases, intact physical education classes were randomly selected from the physical education schedule. Effort was made to include only bias-free groups/classes of subjects, i.e., those representative of the general school population.

Normal subjects were selected from testing sites located in urban, suburban, and rural settings. For the purpose of this study, an urban site was one located in a community having a population of 200,000 or greater. A suburban site was defined as a school located in a community of 10,000 or more individuals, but less than 200,000 individuals. A rural site was one located in a community with a population of less than 10,000. A distribution of normal subjects categorized by age, sex, and community size is presented in Table 2.2.

Impaired Subject Selection

The sample of subjects with impairments was selected from testing sites which agreed to participate in the study. Since the availability of subjects at sites never exceeded the sample sizes needed, every eligible subject that could be tested was tested, and random sampling was not applicable. Also, since

TABLE 2.2. NORMAL SUBJECTS CATEGORIZED BY SEX, AGE, AND COMMUNITY SIZE.

				Rural					
Ages	10	11	12	13	14	15	16	17	Total
Boys	22	11	19	22	13	7	7	14	115
Girls	30	21	28	42	24	12	8	17	182
				Suburban					
Ages	10	11	12	13	14	15	16	17	Total
Boys	44	52	61	24	25	35	50	13	304
Girls	31	41	50	29	66	36	56	10	319
				Urban					
Ages	10	11	12	13	14	15	16	17	Total
Boys	11	6	13	7	0	19	23	13	92
Girls	10	0	37	60	45	16	8	4	180
Totals	148	131	208	184	173	125	152	71	1192

the number of sites involved never exceeded the total required, there was no reason to apply random sampling procedures to sites selected. However, as with the normal group, only groups/classes of subjects which were felt to be representative of that special population were included.

Subjects with impairments were selected from both institutionalized and non-institutionalized sites. For the purpose of this study, a non-institutionalized site was defined as any school which was not totally segregated by handicapping conditions, or which included both normal and impaired persons. An institutionalized site was defined as either a public or private school/agency attended solely by students with impairments. An institutionalized site was further subcategorized according to the residence of pupils. Those living at home (not at the institution) and attending an institutionalized setting were categorized as non-resident institutionalized. Those residing within the institution were classified as resident institutionalized. A distribution of subjects with impairments categorized by condition and educational environment is presented in Tables 2.3 through 2.7.

A total of 3,914 children and youth between the ages of 10 and 17 were tested during this study. A distribution of these subjects is presented in Table 2.8.

TABLE 2.3. VISUALLY IMPAIRED SUBJECTS CATEGORIZED BY CONDITION AND EDUCATIONAL ENVIRONMENT.

Institutionalized									
				Partially Sighted					
Ages	10	11	12	13	14	15	16	17	Total
Boys	20	25	27	24	36	29	29	34	224
Girls	4	17	16	20	20	17	14	23	131
				Blind					
Ages	10	11	12	13	14	15	16	17	Total
Boys	4	3	3	10	11	14	10	11	66
Girls	5	7	7	7	6	9	8	6	55
Non-Institutionalized									
				Partially Sighted					
Ages	10	11	12	13	14	15	16	17	Total
Boys	13	5	10	7	18	11	15	1	80
Girls	3	2	7	7	9	10	11	5	54
				Blind					
Ages	10	11	12	13	14	15	16	17	Total
Boys	2	0	1	2	4	3	4	1	17
Girls	2	1	1	5	3	7	2	1	22
Totals	53	60	72	82	107	100	93	82	649

TABLE 2.4. AUDITORY IMPAIRED SUBJECTS CATEGORIZED BY CONDITION AND EDUCATIONAL ENVIRONMENT.

Institutionalized									
				Hard of Hearing					
Ages	10	11	12	13	14	15	16	17	Total
Boys	10	9	8	10	8	21	32	22	120
Girls	4	4	9	7	6	10	26	13	79
				Deaf					
Ages	10	11	12	13	14	15	16	17	Total
Boys	54	44	43	61	58	108	152	67	587
Girls	30	43	38	56	59	95	109	53	483
Non-Institutionalized									
				Hard of Hearing					
Ages	10	11	12	13	14	15	16	17	Total
Boys	2	8	5	8	5	2	4	3	37
Girls	3	4	4	4	3	4	7	0	29
				Deaf					
Ages	10	11	12	13	14	15	16	17	Total
Boys	6	8	10	20	13	11	11	0	79
Girls	3	8	5	11	8	15	2	2	54
Totals	112	128	122	177	160	266	343	160	1468

TABLE 2.5. CEREBRAL PALSY SUBJECTS CATEGORIZED BY CONDITION AND EDUCATIONAL ENVIRONMENT.

Institutionalized									
				Ambulant					
Ages	10	11	12	13	14	15	16	17	Total
Boys	2	2	0	3	6	7	3	2	25
Girls	4	1	3	1	8	4	2	3	26
				Wheelchair					
Ages	10	11	12	13	14	15	16	17	Total
Boys	6	7	4	7	5	5	8	4	46
Girls	2	4	2	7	6	4	2	6	33
Non-Institutionalized									
				Ambulant					
Ages	10	11	12	13	14	15	16	17	Total
Boys	19	19	11	16	12	6	8	7	98
Girls	14	15	9	13	6	7	5	6	75
				Wheelchair					
Ages	10	11	12	13	14	15	16	17	Total
Boys	11	5	6	2	4	4	5	3	40
Girls	3	3	7	11	7	5	3	2	41
Totals	61	56	42	60	54	42	36	33	384 + 12 396*

*Includes 12 subjects who were not classified according to educational environment.

TABLE 2.6. SPINAL NEUROMUSCULAR SUBJECTS CATEGORIZED BY CONDITION AND EDUCATIONAL ENVIRONMENT.

Institutionalized									
				Paraplegic					
Ages	10	11	12	13	14	15	16	17	Total
Boys	4	1	5	2	1	5	2	6	26
Girls	3	5	2	2	1	6	4	2	25
				Quadriplegic					
Ages	10	11	12	13	14	15	16	17	Total
Boys	0	0	0	0	0	0	0	0	0
Girls	0	0	0	0	0	0	0	1	1
Non-Institutionalized									
				Paraplegic					
Ages	10	11	12	13	14	15	16	17	Total
Boys	9	8	5	5	7	5	3	4	46
Girls	13	9	8	3	4	4	2	1	44
				Quadriplegic					
Ages	10	11	12	13	14	15	16	17	Total
Boys	0	0	1	0	0	0	0	1	2
Girls	0	0	0	1	0	1	0	1	3
Totals	29	23	21	13	13	21	11	16	147

TABLE 2.7. ANOMALY/AMPUTEE SUBJECTS CATEGORIZED BY CONDITION AND EDUCATIONAL ENVIRONMENT.

Institutionalized									
				Anomaly					
Ages	10	11	12	13	14	15	16	17	Total
Boys	2	2	0	3	1	0	1	0	9
Girls	1	0	1	0	1	2	0	1	6
				Amputee					
Ages	10	11	12	13	14	15	16	17	Total
Boys	0	0	0	1	0	0	1	2	4
Girls	1	0	0	2	1	0	0	0	4
Non-Institutionalized									
				Anomaly					
Ages	10	11	12	13	14	15	16	17	Total
Boys	2	3	1	1	1	4	0	3	15
Girls	1	1	0	3	2	1	2	2	12
				Amputee					
Ages	10	11	12	13	14	15	16	17	Total
Boys	3	2	0	0	0	0	0	3	8
Girls	0	0	0	2	1	0	1	0	4
Totals	10	8	2	12	7	7	5	11	62

TABLE 2.8. NUMBER OF SUBJECTS CATEGORIZED BY CONDITION, SEX, AND AGE.

Age	Normal		Visually Impaired		Auditory Impaired		Orthopedic Impaired	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
10	77	71	39	14	72	40	60	42
11	69	62	33	27	69	59	52	38
12	93	115	41	31	66	56	35	33
13	53	131	43	39	99	78	40	45
14	38	135	69	38	84	76	37	37
15	61	64	57	43	142	124	37	34
16	80	72	58	35	199	144	32	22
17	40	31	47	35	92	68	35	26
Sub-Totals	511	681	387	262	823	645	328	277
TOTALS	1,192		649		1,468		605	
							GRAND TOTAL	3,914

Subject Definitions, Categories, Codes

For the purposes of this study, four major categories of subjects were identified: normal (non-impaired), the visually impaired, auditory impaired, and orthopedic impaired. The definitions included for subject selection were in accordance with the rules and regulations governing PL 94-142 (Federal Register, August 23, 1977). The purpose of this section is to interpret and clarify the definitions of the populations utilized in the present study.

The primary system used to categorize subjects in this study consisted of assigning each subject a three-digit number which corresponded to the subject's handicapping condition. These "condition codes" may be found in Appendix A.

Normal (Non-Impaired)

For the purposes of this study, a normal or non-impaired subject was one who was (1) not identified as handicapped by the school district, (2) free from physical impairments or disabilities which may have influenced test results, and (3) attended regular classes in non-institutionalized regular schools.

Visually Impaired

Subjects with visual impairments included the blind and the partially sighted. The blind included those subjects with a visual acuity for distance vision of 20/200 or less in the better eye with best correction; or visual acuity of more than 20/200 if the width diameter of field vision substended an angle no greater than 20 degrees; or were those who could not read print and needed instruction in braille. Partially sighted subjects were those children with a visual acuity of 20/200, but less than 20/70 with correction; or those children who were able to be educated through the medium of vision with special aids. Determination of groupings was made by the school/agency the individual attended. Pupils with visual impairments were further classified based upon the onset of the condition. The onset of the condition was categorized as occurring either congenitally, between birth and age six, or after age six.

Auditory Impaired

Subjects with auditory impairments included the deaf and hard of hearing. For the purposes of this study, hard of hearing was defined as decible loss ranging from 27-90 db in the better ear or when the sense of hearing, although defective, was functional with or without a hearing aid, but hearing ability was subnormal. Hard of hearing also meant a hearing impairment, whether permanent or fluctuating, which adversely affected a child's educational performance, but which was not included under the definition of deaf. The deaf included those individuals who had a hearing loss of 91 db or greater in the better ear or whose hearing was nonfunctional for the ordinary purposes of life, and/or deaf meant a hearing impairment which was so severe that the child was impaired in processing linguistic information through hearing with or without amplification and which adversely affected educational performance.

Orthopedic Impaired

According to PL 94-142, orthopedic impaired refers to those persons whose impairment adversely affects their educational performance. It includes impairments caused by congenital anomaly (e.g., poliomyelities, bone tuberculosis, etc.), and impairments from other causes (e.g., cerebral palsy, amputations, and fractures or burns which cause contractures). For the purposes of this study, this definition was employed. Not all types of subjects with orthopedic impairments, however, were included. This study subdivided the orthopedic category into the following four divisions: amputations, congenital anomalies, cerebral palsy, and spinal neuromuscular conditions. Amputees were subjects who had part or all of one or more of their extremities missing. Thus, amputations were congenital or acquired. Subjects identified as possessing congenital anomalies included, for the purposes of this study, individuals whose extremities were fully or partially present but were deformed. In the case of congenital anomalies, the conditions must have been present at birth. Spinal neuromuscular conditions were conceptualized as acquired or congenital conditions characterized by spinal lesion which directly affected limb functioning. However, subjects with progressive muscular conditions associated with spinal lesions were not included in the study. Cerebral palsy was defined as a disorder characterized by disturbances in voluntary motor functioning resulting from lesions in the brain that affect the motor control centers.

For the purposes of subject selection, test administration, and data analysis, the four orthopedic categories were further subclassified. The amputee and congenital anomaly subclassifications were based on extremity involvement and included one-arm only, two-arm only, one-leg only, two-leg only, one-arm and one-leg (same side), and one-arm and one-leg (opposite side). In addition, test items were selected for tri- and quad-amputees and congenital anomalies based upon subject ability. These groups were excluded if they could not be appropriately evaluated on any test item.

Spinal neuromuscular conditions were subclassified based upon the site of spinal cord lesion. These categories were adopted from the classification system of the National Wheelchair Athletic Association (NWAA) and were as follows: (1) all cervical lesions, (2) lesions from T1 (first thoracic vertebrae) to T5, (3) lesions from T6 to T10, (4) lesions from T11 to L2 (second lumbar vertebrae), and (5) lesions at or below L3. For the purpose of test selection, testers were required only to classify spinal neuromuscular subjects as either quadriplegic or paraplegic. Quadriplegic was defined as all cervical lesions, and paraplegic was considered to be those lesions occurring at or below T1. (If the subject had been previously classified by the NWAA, the tester was asked to record the classification. The NWAA classification system may be found in the modifications section of this chapter.)

The subclassifications of the cerebral palsied followed the 1979 sport classifications of the National Association of Sports for Cerebral Palsy (NASCP). All cerebral palsied subjects were placed in one of the eight NASCP classifications for this study. Classifications were made by Project UNIQUE testers. This classification system appears in the modifications section of this chapter. Cerebral palsied subjects were also classified based upon the type of cerebral palsy (spastic, athetoid, ataxic, rigid, tremor, or mixed) and limb involvement (monoplegia, diplegia, triplegia, hemiplegia, paraplegia, or quadriplegia).

According to the above definitions and classifications, the following are examples of handicapping conditions which were included in the study:

1. Amputations - any extremity or combination

2. Congenital Anomalies - club foot, deformed limbs (non-spinal conditions)

3. Spinal Neuromuscular Conditions - post-polio, spina bifida, spinal cord lesions

4. Cerebral Palsy

The following are examples of conditions which were not involved in the study as primary handicapping conditions:

Arthritis
Multiple Sclerosis
Muscular Dystrophy and Other Dystrophies
Temporary Orthopedic Disabilities
Osgood-Schlatter's Disease
Scoliosis and Other Structural Spinal/Postural Disabilities
Cystic Fibrosis
Diabetes Mellitus
Cardiovascular Disorders (congenital or acquired)
Respiratory Disorders
Arthrogryposis

Multiple Impairments

In selecting subjects for this study, the reality of individuals with multiple impairments was of tremendous concern. Subjects with multiple handicapping conditions were not ordinarily selected for this study. The exception to this occurred in cases where additional handicapping conditions did not significantly affect performance on the physical fitness items included in the study. For example, it was permissible to include an individual with cerebral palsy who, in addition, had some minor learning disability. However, if it was felt that the learning disability would seriously affect performance on the test items, the individual was not included. In regard to mental retardation, educable, trainable, and profoundly retarded individuals were not included in the selection of subjects. The intelligence quotient for mental retardation was set at 69 or below. Individuals identified as slow learners were included in the study if they possessed one of the major handicapping conditions under investigation.

Description of Tests and Test Procedures

A description of tests and test procedures employed in this study are described in this section. This description includes: a brief description of the test items, the type of facility recommended for testing, equipment needed, scoring and trials, and procedures pertaining to group testing. It was suggested that the items be administered in the following order: body composition measures, sit-ups, timed leg raise, timed trunk raise, rise-to-stand, mat creep, shuttle run, modified stork test, sit and reach, grip strength, flexed arm hang, pull-ups, 50-yard/meter dash, standing broad jump, softball thorw, and long distance run. Testers were advised to demonstrate items to subjects. Testers were informed that subjects should not be tested on more than half the items during any one test day. Testers were instructed not to test subjects in environments where the temperature was above 90 degrees or below 50 degrees, or where temperature plus humidity exceeded 175.

A positive approach toward subjects participating in this study was emphasized. Testers were instructed to encourage subjects to try as hard as possible and to give verbal reinforcement after each trial on an activity. Enthusiastic encouragement by the tester during the administration of test items was emphasized so that each subject's participation in the testing would be a positive experience. On the other hand, testers were encouraged to discourage razzing or cheering by observers (including subjects in the group) in all performances, but particularly running events.

Body Composition Measures

Test Items

Triceps Skinfold, Subscapular Skinfold, Abdominal Skinfold, Height, and Weight

Facility

Testers were instructed to obtain anthropometric measurements in a gymnasium, office, or other enclosed area.

Equipment

Lange skinfold fat caliper, green felt tip pen, stadiometer, and calibrated scale.

Procedure - Skinfold Measures

Description

Skinfold measures were taken at the triceps, subscapular, and abdominal regions. Testers obtained three readings at each site for each subject. A green felt tip pen was used to mark a dot at the exact spot at which measures were taken. Skinfolds were obtained by grasping the skin and underlying fat between the thumb and index finger with the span of the grasp dependent upon the thickness of the skinfold. The skinfold caliper was

applied approximately one centimeter (less than one-half inch) above the fingers holding the skinfold. All skinfold measurements were taken in the following order: triceps, subscapular, abdomen. This order was repeated for the second and third measurements.

Triceps

The triceps skinfold was taken at the back of the dominant arm, midway between the elbow and the apex of the armpit. With the subject's arm freely hanging, the skinfold was taken parallel to the long axis of the arm. The triceps skinfold was a vertical fold and is illustrated in Figure 2.2a.

Subscapular

The subscapular skinfold was taken at a site one inch below and medial to the inferior angle of the scapula on the dominant side. The subscapular skinfold was taken at an angle (in line with the natural cleavage lines of the skin) depicted in Figure 2.2b.

Abdominal

The abdominal skinfold was a vertical fold taken at a site two inches to the right of the person's midline, in line with the umbilicus, and parallel to the long axis of the body. The abdominal skinfold site is shown in Figure 2.2c.

Scoring and Trials

Skinfold measurements were recorded to the nearest millimeter. Three readings were obtained at each site for each subject. In addition, the mean of the three site readings were recorded.

Procedures - Height and Weight

Description

Height was measured by having the subject stand facing the tester with shoes removed. Weight was taken by having the subject stand on a scale. Subjects removed their shoes and were clothed in lightweight athletic attire when tested.

Scoring and Trials

Single determinations of height and weight were taken. Height readings were recorded to the nearest half inch, and weight readings were recorded to the nearest pound.

Muscular Strength/Endurance

Test Items

Timed flexed knee sit-ups, timed leg raise, timed trunk raise,

A. Triceps skinfold

B. Subscapular skinfold

C. Abdominal skinfold

Figure 2.2 Anthropometric measures

right and left grip strength, flexed arm hang, pull-ups, standing broad jump, and softball throw.

Facility

Gymnasium or outdoor surface. It was recommended that the softball throw be performed outdoors.

Equipment

Floor mat, stopwatch, one-foot ruler, hand dynamometer, horizontal bar, tape measure, softball, and 2" X 2" X 4" block.

Procedure - Flexed Knee Sit-Ups

Description

In the flexed knee sit-up test, subjects were tested to determine the number of sit-ups which could be performed in 60 seconds. To start, each subject assumed the supine lying position with knees bent, feet on the floor, and heels not more than twelve inches from the buttocks. The subject then crossed the arms and placed their hands securely on the opposite shoulder and maintained this position throughout the sit-up. Subjects were required to touch the knee-thigh area on the rise and to place the midback in complete contact with the testing surface on the return to supine. The subject's feet were held by a partner to keep them in touch with the surface. Each rise from the supine to the correct sit-up position was counted as one sit-up. The required body position for the sit-up is illustrated in Figure 2.3.

Scoring and Trials

One trial was administered for the sit-up test. The subject's score was the total number of sit-ups executed in 60 seconds.

Group Testing

In order to expedite testing, it was permissible for a group of 10 participants--10 partners--to be tested at one time. Partners assumed the normal assisting position and counted aloud, yet softly, the running count of the number of sit-ups executed by the subject.

Procedure - Timed Leg Raise

Description

In the leg raise, the subject was tested to determine the length of time that straightened legs could be held. This test item was begun from a supine position with clasped hands placed behind the head/neck area, the elbows flat on the floor, legs straight, and both feet and legs together. From this position, both legs were elevated to approximately 12 inches above the floor and held for as long as possible (see Figure 2.4). If the subject's legs bent, separated, or became heightened or lowered more than three inches above the 12-inch mark, the timing of this activity ceased. It was recommended that

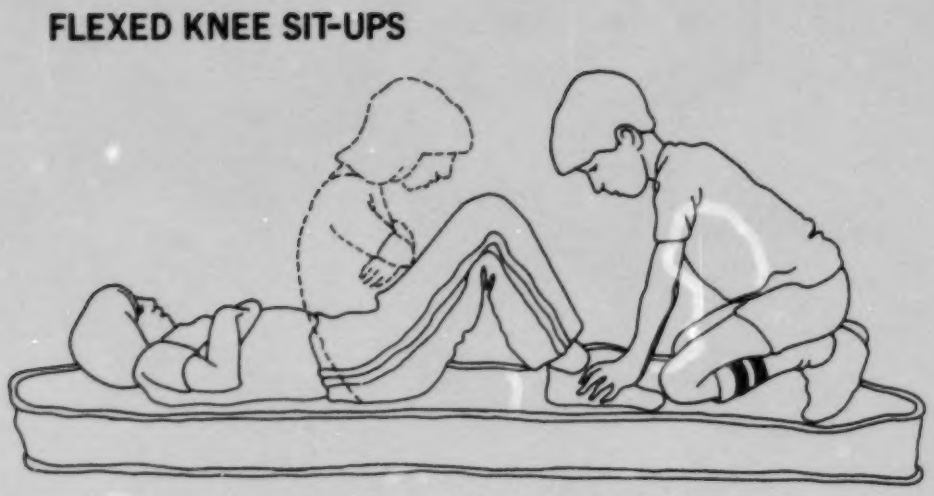

Figure 2.3 Flexed knee sit-ups

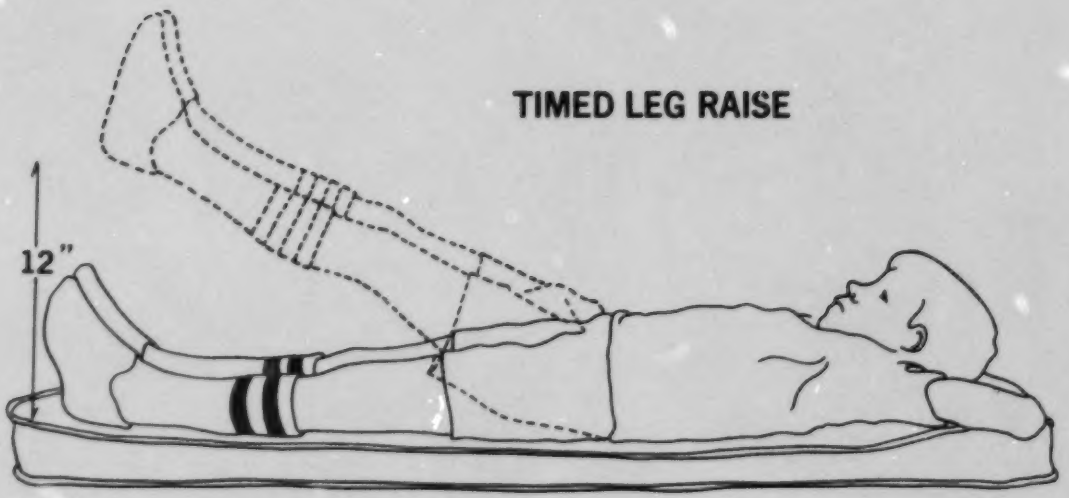

Figure 2.4 Timed leg raise

testers place a one-foot ruler on the floor under the subject's heels to determine height. Once timing began, it was recommended that the ruler be moved to the side and be used as a guide.

Scoring and Trials

The subject's score was the number of seconds that the legs were held in the desired position. Only one trial was given for this activity.

Group Testing

Testers were permitted to test a group of five subjects on the trunk raise at one time (equipment permitting).

Procedure - Timed Trunk Raise

Description

In this test, the subject was tested to determine the length of time that the hyperextended trunk could be held in a raised position from the prone. The starting position for this test item was a prone position on a gym mat in such a way that the upper body above the illiac crest (belt line) protruded beyond the edge of the mat. The fingers were clasped and placed in contact with the head with the elbows pointed outward and the calves of the subject were held down. From this position, the subject hyperextended the back and attempted to hold this position for as long as possible. Timing ceased when the subject lowered the trunk from the hyperextended position. Testers were encouraged to place a 2" x 2" x 4" wooden block to the side of each subject to serve as a guide for the hyperextended criterion for the cessation of timing. The timed trunk raise is depicted in figure 2.5.

Scoring and Trials

The subject's score on this test item was the number of seconds that the subject was able to hold the required hyperextended position. Each subject performed one trial in this test item. A brief practice trial was permitted.

Group Testing

Testers were permitted to test a group of five persons on the trunk raise at one time (equipment permitting).

Procedure - Right and Left Grip Strength

Description

In grip strength tests, subjects squeezed a hand dynamometer with maximum force. Right and left grip strength was measured with the use of an adjustable hand grip dynamometer (Preston PC5032). The dynamometer was adjusted for each subject so that the middle joint (second joint) of the fingers fit firmly around the pulling mechanism as the heel of the hand was placed at the base of the dynamometer and the thumb was wrapped around the

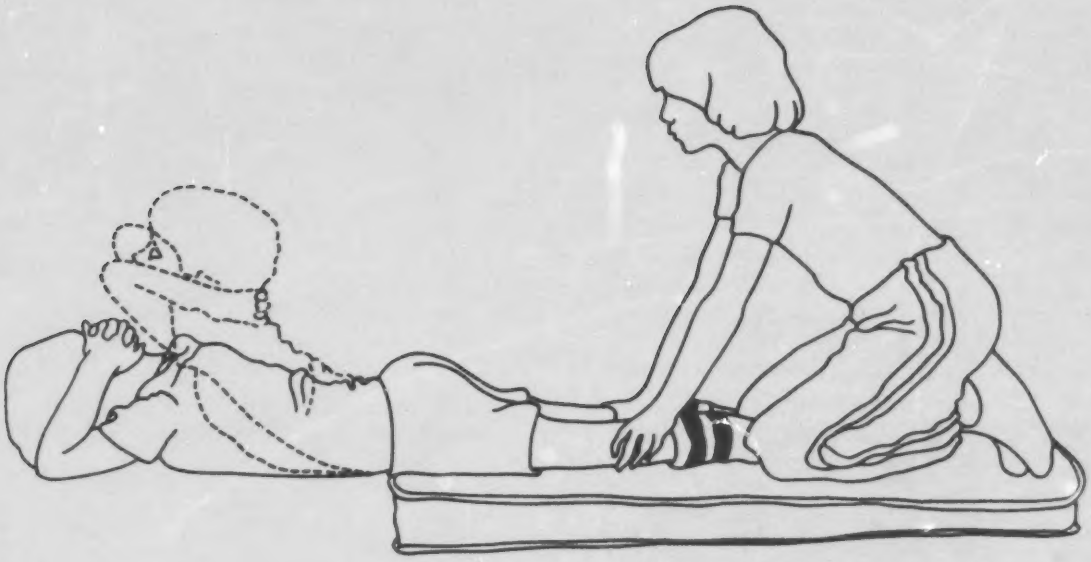

Figure 2.5 Timed trunk raise

base. The subjects squeezed the dynamometer while seated in a straight back desk chair. Hand and arm contact with the seat or any other obstacles which might provide additional leverage or impede movement was not permitted. The desired position is demonstrated in Figure 2.6. At the signal to begin, the subject squeezed the dynamometer as hard as possible with the arm extended downward.

Scoring and Trials

The score for each trial was recorded to the nearest kilogram. The average of the three trials for the right hand and the average of the three trials with the left hand were recorded. Three trials were given for each subject with each hand. Right and left hand trials were alternated as subjects were tested.

Procedure - Flexed Arm Hang

Description

In the flexed arm hang, the subject grasped a horizontal bar using an overhand (pronated) grip, the elbows flexed, the chest close to the bar, and the chin over the bar (see Figure 2.7), and attempted to hold this position for as long as possible. If the chin of the subject rested on the bar, the subject tilted the head back in an attempt to keep above the bar, or the subject's chin fell below the bar, timing of this activity ceased. Each subject was provided two trials on the flexed arm hang with a minimum of one minute rest interval provided between the trials. Testers were encouraged to administer the second trial after a complete class was tested to allow rest between trials. It was recommended that spotters be used to help subjects assume the proper starting position and to prevent injury from falling. However, spotters were not permitted to touch subjects as they performed the test item.

Scoring and Trials

Two trials were administered to each subject. The time, correct to the nearest second, that the subject correctly maintained the flexed arm hang position was the trial score for each subject. The subject's score on this test item was the mean score of two trials.

Procedure - Pull-Ups

Description

The pull-up test required a subject to perform as many chin-ups from a horizontal bar as possible. The starting position for the pull-up was a hang position using an overhand (pronated) grip. From this position, the subject attempted to raise the body upward to a chin above the bar position. The subject then lowered to the original starting position and repeated this process as many times as possible (see Figure 2.8). The body of the subject was not permitted to swing, kick, or push off the floor with their feet during the pull-up. Testers or spotters were permitted to prevent swinging by extending their arms in front of the subject's thighs, help students grasp the bar, and to prevent injury from falling. However, spotters

Figure 2.6 Right and left grip strength

Figure 2.7 Flexed arm hang

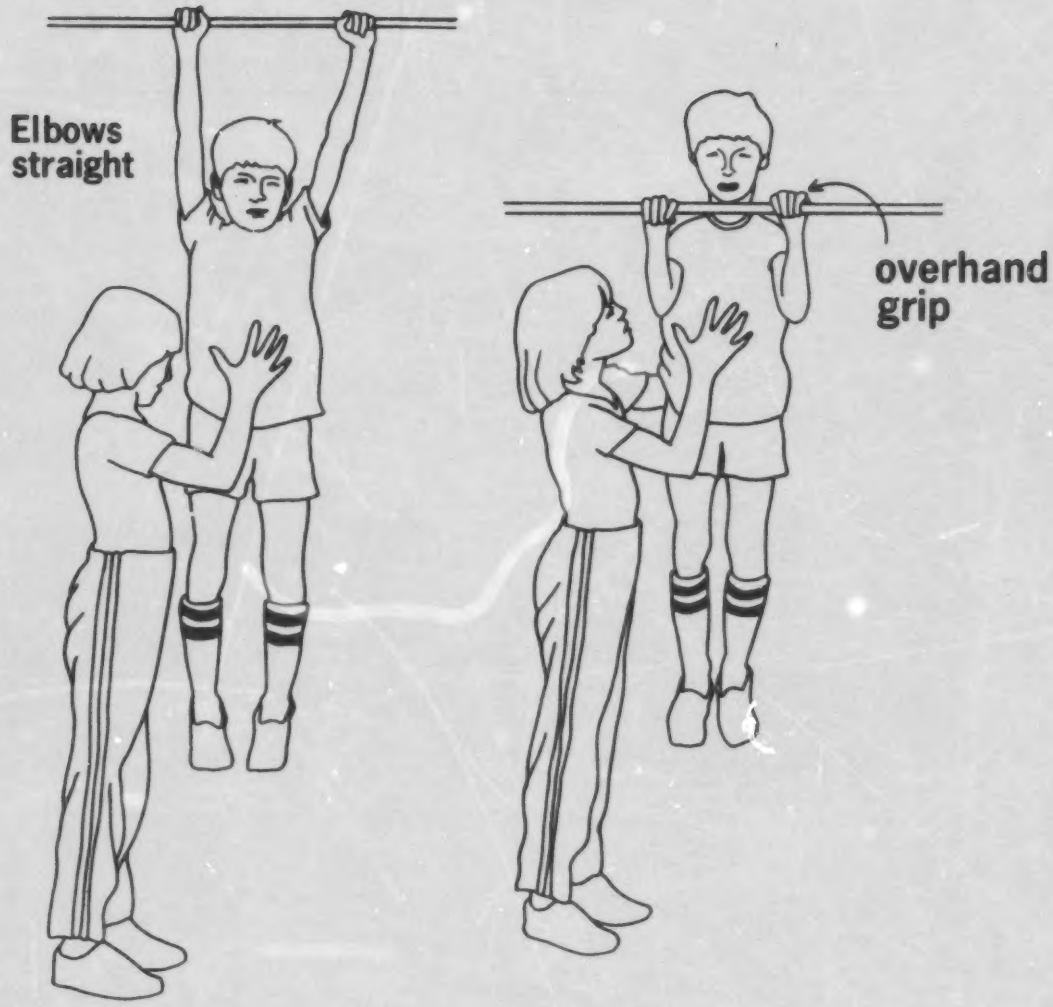

Figure 2.8 Pull-up

were not permitted to touch subjects as they attempted to perform pull-ups. Improperly performed pull-ups were not counted.

Scoring and Trials

One trial was administered in the pull-up test. The score attained by the subject was the number of successfully completed pull-ups.

Procedure - Standing Broad Jump

Description

In the standing broad jump, subjects were directed to jump as far as possible from a take-off line using a two foot take-off and landing on both feet. The jump was measured from the take-off line to the point nearest the take-off line where the subject's back heel touched the floor or ground. It was recommended that each subject be permitted a practice trial during which measuring procedures and the importance of the arm swinging and body rocking for maximum performance were explained.

Scoring and Trials

Scoring for the standing broad jump consisted of recording the distance the subject jumped (heel mark) in feet and inches to the nearest rounded inch. Each subject was provided three trials. The subject's score in this test item was determined by computing the mean score of the three trials.

Group Testing

It was permissible for two subjects to be tested at one time--one on each side of a measuring tape.

Procedure - Softball Throw

Description

For this test item, each subject was instructed to throw a regulation softball overhand at an angle of approximately 40 degrees as far forward as possible. Subjects were permitted one forward step during the overhand throwing motion. A stopwatch was started at the time that the ball was released from the subject's hand and stopped when the ball landed on the ground. It was recommended that all subjects be permitted to warm-up before throwing any distances (practice or actual). Testers were asked not to test subjects during excessive wind conditions (15 mph or more). The softball throw is illustrated in Figure 2.10.

Scoring and Trials

Each subject was allowed two practice throws and three test throws. Two scores were recorded for each softball throw trial. The first score was a timed score in tenths of a second and represented the flight time of the subject's throw. The second score was a distance score. It

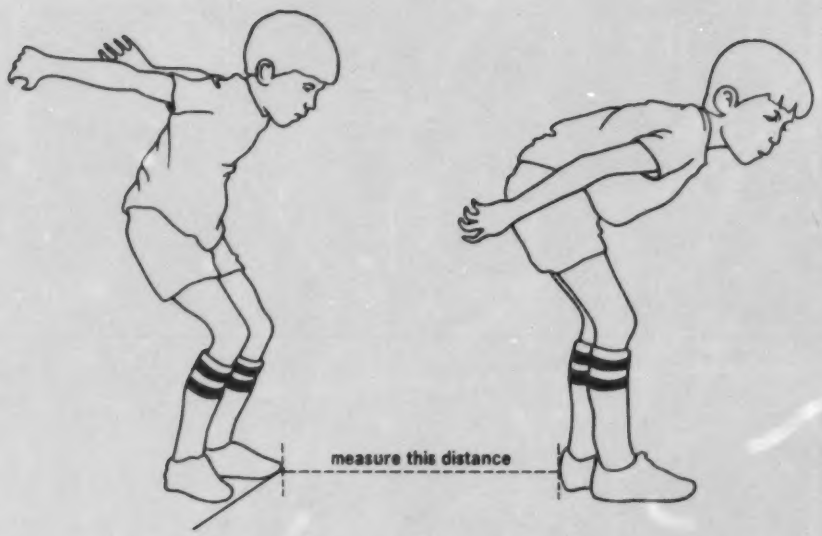

Figure 2.9 Standing broad jump

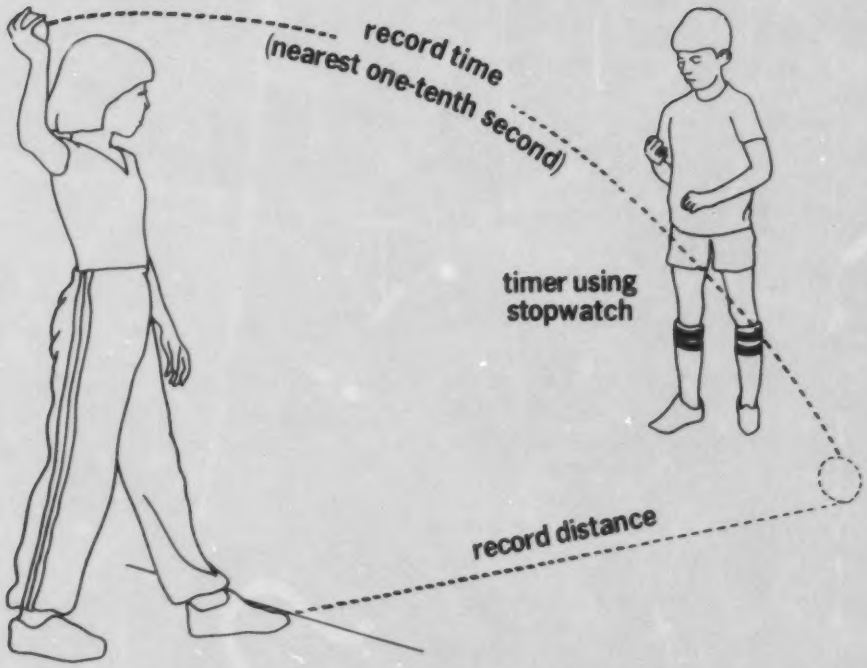

Figure 2.10 Softball throw

represented the actual feet and inches that the ball traveled. Averaged trial times and trial distance scores were also recorded on this test item.

Speed

Test Items

50-Yard/Meter Dash

Facility

Although an outdoor area is preferred, an indoor or outdoor area may be used for the 50-yard/meter dash.

Equipment

Stopwatch

Procedure - 50-Yard/Meter Dash

Description

This test item was administered to determine each subject's speed in performing both 50-yard and 50-meter runs. Subjects were shown the starting line and the finish line of a 50-meter course and were instructed to run 50 meters as fast as possible in a straight line. Subjects were told that two times would be determined: one at 50 yards and the second at 50 meters. Timers positioned themselves between the 50-yard finish line and the 50-meter (55 yards) finish line. Both 50-yard and 50-meter finish lines were marked and subjects were instructed to run to the second line. Time at the 50-yard mark and 50-meter mark was measured. The 50-yard/meter dash was begun by having the tester raise his/her hand above their head to signify READY. The tester then dropped the hand by their thigh and called out GO to begin the test. Mistrials were repeated. All subjects were required to wear athletic sneakers and were tested on a hard, flat surface. Testers were encouraged to become proficient in using stopwatches prior to administering this test item.

Scoring and Trials

The score for the 50-yard/meter dash was the amount of time (seconds and tenths) it took a subject to run from the starting line to the 50-yard and 50-meter finishing lines. Scores were rec[illegible]d for both distances. Only one trial was administered.

Group Testing

It was recommended that two subjects run the test at the same time.

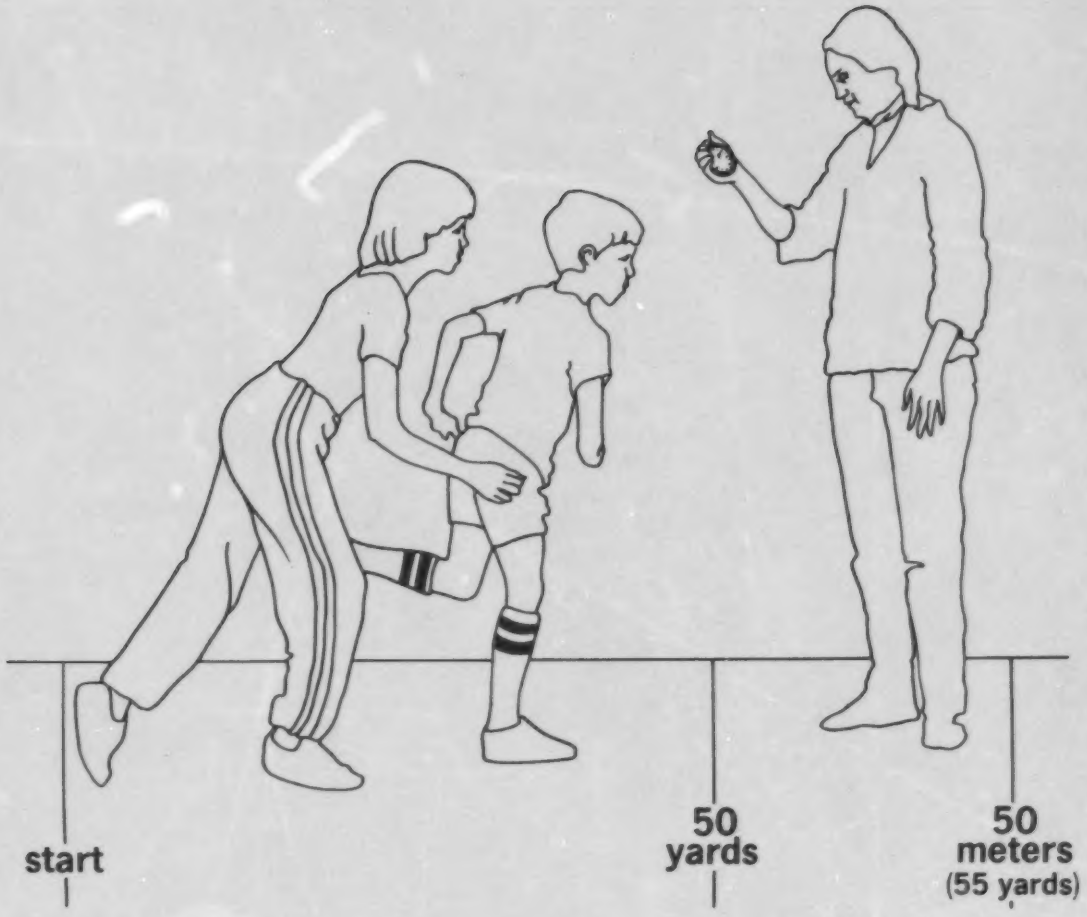

Figure 2.11 50-yard/meter dash

Agility

Test Items

Rise-to-Stand, Mat Creep, Shuttle Run

Facility

Indoor gymnasium or large room preferred. Flat level outdoor surfaces were acceptable.

Equipment

Gymnasium mat, stopwatch, tape, plastic pylons or other suitable markers, and four blocks of wood 2" X 2" X 4".

Procedure - Rise-to-Stand

Description

In this test item, subjects were asked to move from a supine position on a mat to a stable standing position as quickly as possible. The supine position on a mat was the starting position for the rise-to-stand. The hands of each subject were placed by their side, palms down. From this position, the subject moved to a standing position as quickly as possible. To signal, testers raised their hand above their head in clear view to the subject and said READY. When the hand was dropped to the thigh area and the instructor said GO, the subject began. Testers ceased timing when the subject came to a stable standing position.

Scoring and Trials

Each subject was administered three trials. The time elapsed (correct to the nearest tenth of a second) in assuming a standing position from a supine position was recorded. The mean of the three trial scores was also recorded.

Procedure - Mat Creep

Description

In this test, subjects creeped on their hands and knees on a mat as quickly as possible from a starting line to and around a pylon eight feet away and then back to the finish line. Subjects were required to creep rather than pivot around the pylon. Knee pads could be worn by subjects to prevent abrasions. The subjects were signaled to begin by having the tester raise their hand above their head, verbally commanding READY, and dropping their hand to their thigh, verbally commanding GO! The stopwatch was started on the GO command and stopped as soon as any body part broke the plane of the finish line on the mat.

Scoring and Trials

Subjects were provided three trials. The subject's trial score was the time (correct to the nearest tenth of a second) that it took a subject to complete the mat creep. The mean of trial scores was recorded.

Procedure - Shuttle Run

Description

In the shuttle run (Figure 2.12), subjects ran 30 feet from a starting line, picked up a 2" X 2" X 4" block, ran back to the starting line, placed the block behind the starting line, ran 30 feet, picked up another block, and ran back to the starting line (subjects were not required to place the second block on the ground or floor). Thus, the start and finish lines were one in the same. Testers were instructed to test two subjects running in different lanes at one time. Each runner was tested in a lane approximately 15 feet in width and 30 feet in length (plus end line space). All subjects were required to wear athletic sneakers and be tested on a hard, flat surface. Testers were instructed to use both verbal and hand signals to signal subjects. Subjects falling during the test were retested after a brief interval. In case of a false start, subjects were retested immediately. It was recommended that timers place themselves in front of the start/finish line to signal the start, and return to the start/finish line to record each subject's time at the finish.

Scoring and Trials

Subjects were permitted two trials for this test item with at least a three-minute rest interval between trials. The trial score for the shuttle run was the amount of time, correct to tenths of a second, that it took to run the complete shuttle course. The mean of trial scores was also recorded.

Group Testing

Testers were instructed to test two subjects running in different lanes at one time.

Flexibility

Test Item

Sit and Reach Test

Facility

Indoor gymnasium or room preferred. Flat level outdoor surfaces were acceptable.

Equipment

The sit and reach test was administered using a sit and reach apparatus (Figure 2.13) or an improvised sit and reach apparatus using a bench and meter stick. The sit and reach apparatus was constructed using plywood.

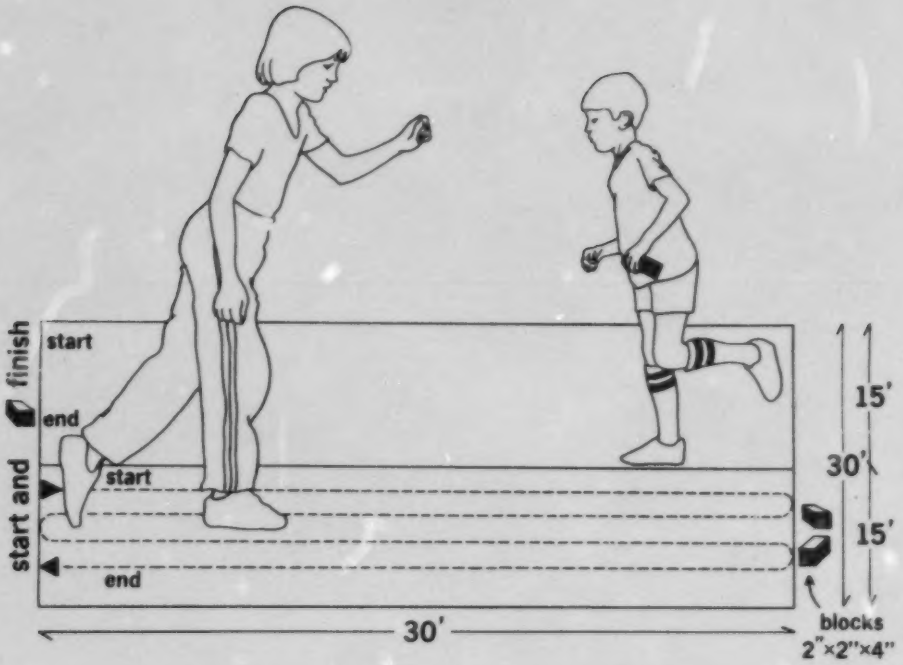

Figure 2.12 Shuttle run

SIT-AND-REACH APPARATUS CONSTRUCTION PROCEDURES

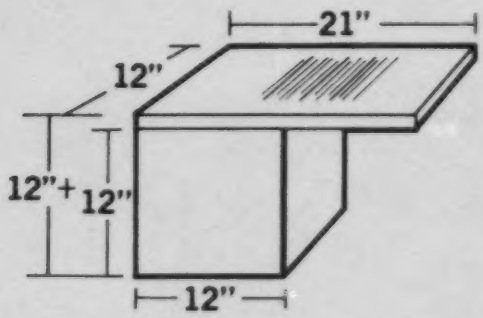

Figure 2.13 Sit and reach apparatus construction procedures

The top panel was marked with one centimeter gradations, with the 23 centimeter line exactly in line with the vertical panel against which the subjects' feet were placed.

Procedure - Sit and Reach Test

Description

In the sit and reach test, each subject was asked to reach forward as far as possible from a sitting position. To start the test, each subject was instructed to lie supine with legs straight, feet placed flush against the sandpapered side of a sit and reach apparatus with shoes removed (see Figure 2.14). From this position, the subject moved to a sitting position. A partner then held down the subject's knees firmly so that they remained in contact with the floor or supporting surface. The subject then extended the arms and hands in front of the body (one hand on top of the other) and attempted to reach past their toes and contact the centimeter measurement board on the sit and reach apparatus with their fingertips. Subjects were cautioned not to bob with their torso, but to slowly reach forward as far as possible four times, and hold for one second on the fourth reach. Testers were instructed to provide a practice trial for each subject.

Scoring and Trials

Two trials of this test item were administered. The trial score on the sit and reach test was the distance, to the nearest centimeter, that the subject was able to reach and hold for one second. Trial scores, as well as the mean of two trial scores, were recorded for each subject.

Cardiorespiratory Endurance

Test Item

One mile/nine-minute run for ages 10 to 12, and a one-and-one-half mile/twelve-minute run for ages 13 and older.

Facility

The run was performed either indoors or outdoors. An outside track 1/8 to 1/4 of a mile was highly recommended. If an indoor facility was used for testing, the minimum course which was constructed was 7 1/2 yards X 20 yards in space. (A subject needed to complete 32 laps of a 20 X 7 1/2 yard course.)

Equipment

Stopwatches, tape, pylons or other suitable markers

Procedure - 1 Mile/9-Minute Run, 1½ Mile/12-Minute Run

Description

This test item was designed to measure cardiorespiratory endurance by measuring the time taken to run one or one-and-one-half miles, or by measuring

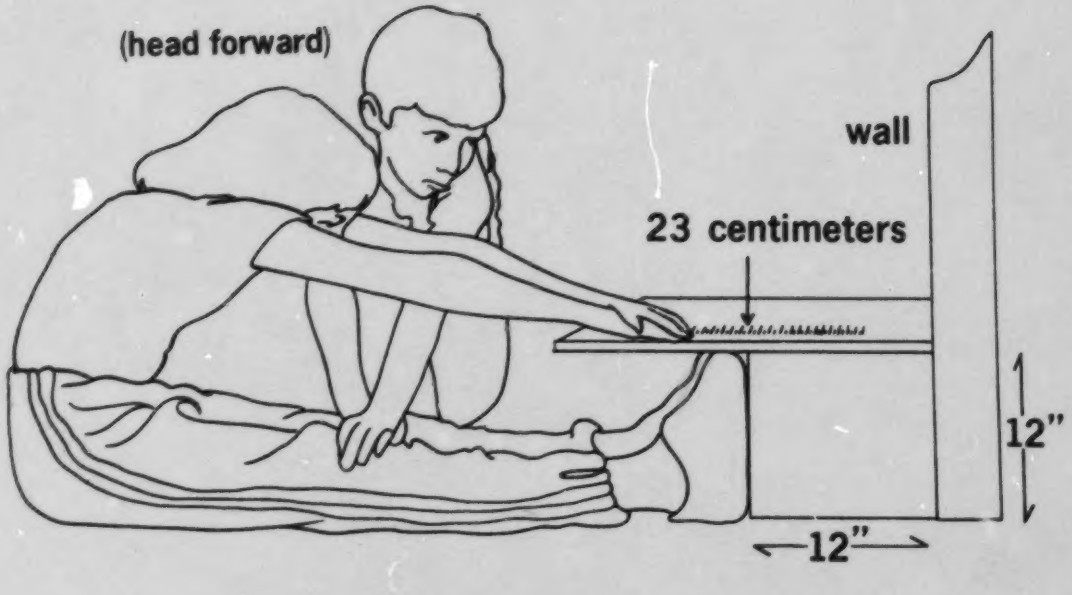

Figure 2.14 Sit and reach test

the distance completed in nine or 12 minutes. Subjects ranging in age from 10 to 12 were instructed to run for one mile or for nine minutes, whichever arrived first. Subjects ranging in age from 13 to 17 were instructed to run for one-and-one-half miles or 12 minutes, whichever came first. Subjects were permitted to walk if they felt tired. However, once the subject came to a stop, the test ended for that subject and distance and time was recorded. Subjects were instructed to pace themselves. Subjects began in the standing position on a hand and verbal signal from the tester. It was necessary for subjects to wear sneakers and athletic clothing.

To facilitate test administration, it was recommended that markers be spread at intervals around the running area. The markers were used to facilitate recording of yardage covered by each subject in the event that a subject did not complete a distance of one or one-and-one-half miles. It was also recommended that testers use assistants to record times when verbally issued by the tester, record the laps completed by each runner, and mark the residual yard distance when a runner stopped before completing the full distance.

Scoring and Trials

One trial of this test item was administered. The actual running time and the actual distance covered by each subject was recorded immediately upon completion of a run. In cases where subjects were unable to complete the one/one-and-one-half mile run for their age group in nine or 12 minutes, respectively, the distance covered in nine or 12 minutes was recorded. In cases where subjects completed the one/one-and-one-half mile run in less than nine or 12 minutes, respectively, this time was recorded. The subject's run was considered finished when the subject: (1) came to a complete stop, (2) expired nine/12 minutes of running time, (3) completed the one/one-and-one-half mile distance. Subject times were recorded in minutes and seconds (nearest whole second). The actual distance covered was recorded in yards.

Group Testing

It was permissible to test up to four subjects at once on this test item.

Static Balance

Test Item

Modified Stork Test

Facility

Indoor gymnasium, large room or a flat outdoor testing surface was permissible.

Equipment

Stopwatch

Procedure - Modified Stork Test

Description

In the modified stork test, the subject attempted to balance in a standing position with the arms folded, eyes closed, and one leg raised off the supporting surface by bending the knee (Figure 2.15). Testers were instructed to place the subject away from obstacles or pointed objects, provide a demonstration of correct procedures, and test at least two subjects at a time. Minute pivoting on the standing leg was permitted to the extent the tester felt that no significant advantage was provided and the individual remained in essentially the same spot. Stopping or placing the raised leg in contact with the standing leg was not permitted. Timing on each trial ceased if the subject allowed the elevated foot to touch the floor, the subject opened eyes, or if their arms unfolded. Testers were instructed to demonstrate the modified stork test to the subject, allow the subjects a brief practice trial, and demonstrate acceptable and unacceptable pivoting.

Scoring and Trials

Each subject was administered three trials. The trial score on the modified stork test was the balancing time, correct to the nearest second, that the individual was able to hold the desired position. The mean of the three trials was recorded.

Group Testing

It was permissible for a group of four to five subjects to be tested on the stork test at one time.

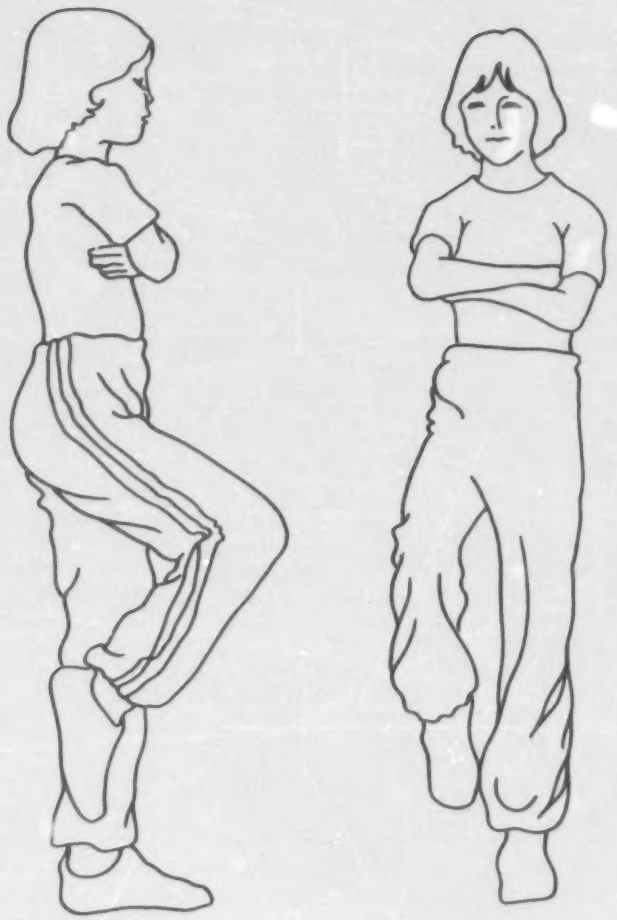

Figure 2.15 Modified stork test

Participation Guides and Test Modifications

In order to accommodate the abilities and limitations of individuals with handicapping conditions, it was necessary, in many cases, to modify or eliminate certain test items for subjects. To enhance data collection, a series of participation guides were developed, one for each of the major subject groups, to identify those items considered appropriate for each population. While each participation guide was developed in consultation with experts in adapted physical activity for the various populations and while testers were encouraged to follow the guides as closely as possible, testers were instructed to eliminate any test item which they believed to be contraindicated for a subject.

The participation guides for each of the subject groups are presented on the following pages. With each participation guide is a description of test modifications which were considered necessary for appropriate participation. Testers could only modify test items as described herein. One modification which applied to certain subject groups was the "run code" classification. For each test item which involved running (shuttle run, 50-yard/meter dash, long distance run), subjects participated using their normal method of ambulation. The method of ambulation employed was noted by the tester as a "run code." The following run codes were available to subjects: (1) moved wheelchair forward with arms, (2) moved wheelchair forward with feet, (3) moved wheelchair backward with feet, (4) used a cane, (5) used crutches, (6) partner assisted, (7) guide wire or rope assisted, (7) used a walker, and (8) unassisted. If the subject employed a method of ambulation different than those described above, he/she was not tested on the running items.

The first participation guide presented here (Table 2.9) was appropriate for normal, auditory impaired, and visually impaired subjects. It was suggested that subjects in these three groups participate in all test items. Normal subjects took all test items without modification. The modifications necessary for auditory impaired subjects were minimal and centered primarily on alternative methods of communicating the requirements of each test item. These adaptations are discussed in terms of general and specific modifications. Visually impaired subjects required additional modifications. Generally, these modifications consisted of conveying directions verbally in combination with tactual and/or kinesthetic cues and allowing subjects a "walk through" practice trial to "get the feel" of the test item. Each test item, with appropriate modification, is discussed separately for the visually impaired group.

TABLE 2.9. PARTICIPATION GUIDE FOR NORMAL, AUDITORY, AND VISUALLY IMPAIRED SUBJECTS.

Test	Participation Guide		
	Normal	Auditory	Visual
1. Body Composition Measures			
Height and Weight	X	X	X
Triceps Skinfold	X	X	X
Subscapular Skinfold	X	X	X
Abdominal Skinfold	X	X	X
2. Muscular Strength/Endurance			
Sit-Ups	X	X	X
Leg Raise	X	X	X
Trunk Raise	X	X	X
Right Grip	X	X	X
Left Grip	X	X	X
Flexed Arm Hang	X	X	X
Pull-Ups	X	X	X
Standing Broad Jump	X	X	X
Softball Throw	X	X	X
3. Speed			
50-Yard/Meter Dash	X	X	X
4. Agility			
Rise-to-Stand	X	X	X
Mat Creep	X	X	X
Shuttle Run	X	X	X
5. Flexibility			
Sit and Reach	X	X	X
6. Cardiorespiratory Endurance			
9-Minute/1-Mile Run or 12-Minute/1½-Mile Run	X	X	X
7. Static Balance			
Modified Stork Test	X	X	X

Test Modifications for the Auditory Impaired

General Modifications

1. Each test item was carefully demonstrated.

2. If possible, instructions to auditory impaired subjects were given by a person skilled in non-verbal communication.

3. If necessary, instructions were given in writing prior to the testing of subjects.

4. All starting and stopping signals were given by hand signals. An elevated arm with the palm of the hand open and facing the subject signified STOP. This signal was similar to that used by a police officer. The GO signal was given by dropping a raised hand from above the head to one's thigh.

Specific Modification

Modified Stork Test

To begin this test, subjects were instructed to close their eyes and begin their balance test when they were touched by the experimenter.

Test Modifications for the Visually Impaired

Body Composition

Height, Weight, Skinfolds

No modifications were considered necessary.

Muscular Strength/Endurance

Timed Flexed Knee Sit-Ups

No modifications were considered necessary.

Timed Leg Raise

No modifications were considered necessary.

Timed Trunk Raise

No modifications were considered necessary.

Right and Left Grip Strength

No modifications were considered necessary.

Flexed Arm Hang

No modifications were considered necessary.

Pull-Ups

No modifications were considered necessary.

Standing Broad Jump

When blind subjects jumped in the practice trial (two trials allowed), touch was used to emphasize the body rock and arm swing. Also, testers touched the back of the subject's heel when explaining distance marking and straddle landings. If the subject requested arm support during the jump, this assistance was provided.

Softball Throw

A tactual aid was placed on the ground so that visually impaired subjects knew the location of the throwing line. The tactual aid could have been a narrow board, a different surface (dirt-grass), or some other device.

Speed

50-Yard/Meter Dash

Blind subjects ran this test under one of two conditions: (1) with a sighted or functionally able partially sighted partner who guided (but did not pull or assist) the blind runner, or (2) alone, but with the tactual aid of a guide rope or wire extended along the course. Partially sighted subjects were given the option of utilizing a partner or running alone. All visually impaired subjects were offered an opportunity to jog or walk the 50 meter distance so that they could familiarize themselves with the course. It was emphasized to visually impaired subjects that there was a considerable amount of clear space after the finish line. If a partner was used, this person must have been able to run at least as fast as the subject.

Agility

Rise-to-Stand

After the rise-to-stand procedures and instructions were explained to the subject, individuals slowly performed a practice trial. This was intended to give the subject a clear idea of the activity. No other modification was considered necessary for blind subjects.

Mat Creep

The only adaptation necessary for blind subjects was providing the subject with a verbal cue when he/she was at a point just past the pylon that they should turn around to creep back to the starting line. This cue was provided by saying TURN AROUND when the subject was just past the pylon. Each subject also was provided with a slow practice trial so that he/she could become faimilar with the course.

Shuttle Run

Blind subjects could run the course under two conditions: (1) with a sighted or functionally able partially sighted partner who was able to run faster than the blind partner, or (2) alone, but with the benefit of a guide rope or wire extended along the course. It was emphasized to blind subjects that there was a considerable amount of clear space after the finish line and that they would be running a short distance. When blind subjects arrived at one end of the run, as indicated by a signal from the tester, they bent down and touched the floor, then returned to the starting line and repeated the process. This procedure was repeated until the shuttle run distance was completed (three surface touches and a running finish). Brightly colored wooden blocks were provided to test partially sighted subjects. Blind and partially sighted subjects were allowed to jog or walk the course in order to become familiar with the test item.

Flexibility

Sit and Reach

The subject's feet were placed in position against the sandpaper side of the box. Two practice trials in which the instructor guided the blind subject through the motion were permitted. No other modifications were considered necessary.

Cardiorespiratory Function

One Mile/Nine-Minute Run, One-and-One-Half Mile/Twelve-Minute Run

Blind subjects ran this test with a normally or functionally able partially sighted partner who guided the blind runner. The blind runner grasped the elbow of the partner or ran hand-in-hand with the partner. Partially sighted subjects were given the option of utilizing a partner or running alone. Visually impaired subjects were offered an opportunity to walk around one or more of the track turns so that they could familiarize themselves with the course.

Static Balance

Modified Stork Test

Blind subjects were allowed a practice trial to provide a clear idea of the activity. No other modification was considered necessary for blind subjects.

Participation Guide and Test Modifications for Subjects with Amputations

The participation guide for subjects with amputations is presented in Table 2.10. Participation for these subjects was largely dependent upon limb involvement. The modifications were not extensive and reflected a "common sense approach" to involving subjects with amputations by slightly altering test procedures. Each test item, with appropriate modification, is subsequently presented for subjects with amputations.

Body Composition Measures

Height and Weight

The height of a subject wearing a prosthetic device was taken with the device on. (The height of a double leg amputee not wearing prostheses was taken from the end of the longest remaining limb to the top of the head, and testers were asked to indicate the site of the amputation on the score sheets.)

The weight of all subjects was taken with braces and prosthetic devices removed.

Triceps, Subscapular, and Abdominal Skinfolds

One-Arm Involvement

The triceps measure was taken on the non-impaired arm.

Two-Arm Involvement

Subjects were not to be tested on the triceps measure if the involvement was above the elbow.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects may have been supported for measurement of subscapular and abdominal fat measures. These measures were taken from a standing position where possible.

One-Arm One-Leg Same-Side Involvement

The triceps measure was taken on the non-impaired arm.

One-Arm One-Leg Opposite-Side Involvement

The triceps measure was taken on the non-impaired arm.

TABLE 2.10. PARTICIPATION GUIDE FOR SUBJECTS WITH AMPUTATIONS.*

Test	Participation by Subclassification					
	One Arm Only	Two Arm Only	One Leg Only	Two Leg Only	One Arm One Leg Same Side	One Arm One Leg Opposite Side
1. Body Composition Measures						
Height and Weight	X	X	X	X	X	X
Triceps Skinfold	X	X**	X	X	X	X
Subscapular Skinfold	X	X	X	X	X	X
Abdominal Skinfold	X	X	X	X	X	X
2. Muscular Strength/Endurance						
Sit-Ups	X	X	X		X	X
Leg Raise	X	X	X		X	X
Trunk Raise	X	X	X		X	X
Right Grip	X or		X	X	X or	X or
Left Grip	X		X	X	X	X
Flexed Arm Hang			X	X		
Pull-Ups			X	X		
Standing Broad Jump	X	X	X		X	X
Softball Throw	X		X	X seated	X	X
3. Speed						
50-Yard/Meter Dash	X	X	X***	X***	X***	X***
4. Agility						
Rise-to-Stand	X	X	X		X	X
Mat Creep	X		X		X	X
Shuttle Run	X	X	X***	X***	X***	X***
5. Flexibility						
Sit and Reach	X		X		X	X
6. Cardiorespiratory Function						
9-Minute/1-Mile Run or 12-Minute/1½-Mile Run	X	X	X***	X***	X***	X***
7. Static Balance						
Modified Stork Test	X	X	X		X	X

*Testers were instructed to administer appropriate tests to tri- and quad-amputees.
**Participation was dependent upon the site of amputation.
***Method of ambulation varied according to ability (see run code classifications).

Muscular Strength/Endurance

Timed Flexed Knee Sit-Ups

One-Arm Involvement

Subjects were required to cross the non-impaired arm on their chest and any possible portion of the impaired arm.

Two-Arm Involvement

Subjects crossed their arms on their chest to the extent possible.

One-Leg Involvement

The non-impaired leg of the subject was held down by a partner; the impaired leg was given as much support as possible.

Two-Leg Involvement

Subjects were not tested on this item.

One-Arm One-Leg Involvement

The non-impaired leg of the subject was held down by a partner and the impaired leg was given as much support as possible. Subjects crossed the non-impaired arm on the chest and any possible portion of the impaired limb.

Timed Leg Raise

One-Arm Involvement

Subjects were required to keep one hand in firm contact with the back of their head and neck at all times.

Two-Arm Involvement

Subjects placed their arms at a backward angle, similar to the position assumed by the upper arms when the hands clasp the head.

One-Leg Involvement

Subjects raised only one leg.

Two-Leg Involvement

Subjects did not participate in this exercise.

One-Arm One-Leg Involvement

Subjects raised one leg and placed one hand behind their head/neck area during the leg raise.

Timed Trunk Raise

One-Arm Involvement

Subjects were required to keep one hand in contact with the back of the head and neck at all times.

Two-Arm Involvement

Subjects placed upper limbs at a backward angle, similar to the position assumed by the upper arms when the hands clasp the head.

One-Leg Involvement

The non-impaired leg was held down and the impaired leg was stabilized to the fullest possible extent.

Two-Leg Involvement

Subjects were supported on the upper thigh and/or buttocks.

One-Arm One-Leg Involvement

The non-impaired leg was secured at the calf and the impaired leg was held down at the upper thigh and/or buttocks, to the fullest possible extent. Subjects placed one hand behind their head/neck area during the trunk raise.

Right and Left Grip Strength

One-Arm Involvement

Subjects performed the test with the non-impaired arm only.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects performed the test with the non-impaired arm only.

Flexed Arm Hang

One-Arm Involvement

Subjects did not participate in this activity.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects did not participate in this activity.

Pull-Ups

One-Arm Involvement

Subjects did not participate in this activity.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects did not participate in this activity.

Standing Broad Jump

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg Involvement

Subjects were allowed to participate in this activity. If the subject requested arm support during the jump, this assistance was provided.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

Subjects were allowed to participate in this activity. If the subject requested arm support during the jump, this assistance was provided.

Softball Throw

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects performed this activity from a seated position in a straight back chair or wheelchair. Subjects were given adequate warm up and two practice trials. Wheelchair participants were instructed to lock their brakes prior to throwing.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Speed

50-Yard/Meter Dash

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One or Two-Leg Involvement

The event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, moved wheelchair backward with feet, used crutches, used a cane, used a walker, or used no assistive device.

One-Arm One-Leg Involvement

The event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, moved wheelchair backward with feet, used crutches, used a cane, used a walker, or used no assistive device.

gility

Rise-to-Stand

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Mat Creep

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Shuttle Run

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects were instructed to bend down so that one knee touched the running surface. When the subject returned to the starting line, he/she bent down and again touched the surface with a knee. This was repeated until the shuttle run distance was complete (three knee touches and a running finish).

One-Leg, Two-Leg Involvement or One-Arm One-Leg Involvement

This event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, moved wheelchair backward with feet, used a cane, used crutches, used a walker, or used no assistive device. If a wheelchair was utilized, the subject wheeled to the wooden blocks which were set up on an inverted wastebasket (size ranging from 15 inches to 25 inches in height). The subject picked up one block and placed it on his/her lap and wheeled back to the starting line. The block then was dropped down to the floor behind the starting line. The subject returned to the second block, picked it up off the basket, placed it in the lap, and wheeled as quickly as possible past the start/finish line to complete the shuttle run. The modified shuttle run is illustrated in Figure 2.16.

Flexibility

Sit and Reach

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

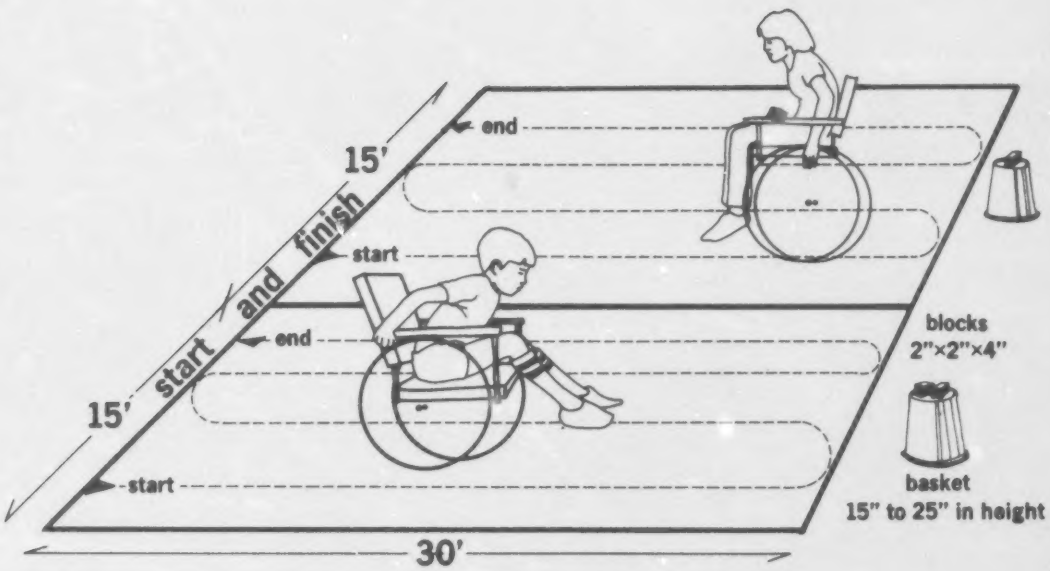

Figure 2.16 Modified shuttle run

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Cardiorespiratory Function

One Mile/Nine-Minute Run, One-and-One-Half Mile/Twelve-Minute Run

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg or Two-Leg Involvement

The event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, moved wheelchair backward with feet, used crutches, used a cane, used a walker, used no assistive device.

One-Arm One-Leg Involvement

This event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, moved wheelchair backward with feet, used crutches, used a cane, used a walker, used no assistive device.

Static Balance

Modified Stork Test

One-Arm Involvement

Subjects were required to cross one arm on their chest and cross any portion of the impaired arm. One-arm amputees were not allowed to extend the impaired limb for balancing purposes.

Two-Arm Involvement

Subjects were required to cross their chest with any portion of impaired limbs they possessed. Two-arm amputees were not allowed to extend their upper limbs as balancing aids.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

Subjects were required to cross one arm on their chest and cross any portion of the impaired arm. One-arm amputees were not allowed to extend the impaired limb for balancing purposes.

Participation Guide and Test Modifications for Subjects with Congenital Anomalies

Test modifications for subjects with congenital anomalies are presented in this section. In addition, the participation guide is presented in Table 2.11.

Body Composition Measures

Height and Weight

The height of a subject wearing a prosthetic device was taken with the device on. (The height of a subject with double leg anomalies not wearing prostheses was taken from the end of the longest remaining limb to the top of the head, and testers were asked to indicate the site of the anomaly on the score sheet.)

The weight of all subjects was taken with braces and prosthetic devices removed.

Triceps, Subscapular, and Abdominal Skinfolds

One-Arm Involvement

The triceps measure was taken on the non-impaired arm.

Two-Arm Involvement

It was not possible to take the triceps measure if the level of involvement was above the elbow on each arm.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects were supported for measurement of subscapular and abdominal fat measures. These measures were taken from a standing position.

One-Arm One-Leg Same-Side Involvement

The triceps measure was taken on the non-impaired arm.

One-Arm One-Leg Opposite-Side Involvement

The triceps measure was taken on the non-impaired arm.

TABLE 2.11. PARTICIPATION GUIDE FOR SUBJECTS WITH CONGENITAL ANOMALIES.*

Test	Participation by Subclassification					
	One Arm Only	Two Arm Only	One Leg Only	Two Leg Only	One Arm One Leg Same Side	One Arm One Leg Opposite Side
1. Body Composition Measures						
Height and Weight	X	X	X	X	X	X
Triceps Skinfold	X	X**	X	X	X	X
Subscapular Skinfold	X	X	X	X	X	X
Abdominal Skinfold	X	X	X	X	X	X
2. Muscular Strength/Endurance						
Sit-Ups	X	X	X		X	X
Leg Raise	X	X	X		X	X
Trunk Raise	X	X	X		X	X
Right Grip	X or		X	X	X or	X or
Left Grip	X		X	X	X	X
Flexed Arm Hang			X	X		
Pull-Ups			X	X		
Standing Broad Jump	X	X	X		X	X
Softball Throw	X		X	X seated	X	X
3. Speed						
50-Yard/Meter Dash	X	X	X***	X[wc]	X***	X***
4. Agility						
Rise-to-Stand	X		X		X	X
Mat Creep	X		X		X	X
Shuttle Run	X	X	X***	X[wc]	X***	X***
5. Flexibility						
Sit and Reach	X		X		X	X
6. Cardiorespiratory Function						
9-Minute/1-Mile Run or 12-Minute/1½-Mile Run	X	X	X**	X[wc]	X***	X***
7. Static Balance						
Modified Stork Test	X	X	X		X	X

wc - Only subjects who used a wheelchair in daily activities were tested on this item.

*Testers were instructed to administer appropriate tests to triplegic and quadriplegic participants.

**Participation was dependent upon the site of anomaly.

***Method of ambulation varied according to ability (see run code classifications).

Muscular Strength/Endurance

Timed Flexed Knee Sit-Ups

One-Arm Involvement

Subjects were required to cross the non-impaired arm on their chest and any possible portion of the impaired arm.

Two-Arm Involvement

Subjects were instructed to cross their arms on their chest to the extent possible.

One-Leg Involvement

The non-impaired leg of the subject was held down by a partner and the impaired leg was supported to the fullest possible extent.

Two-Leg Involvement

Subjects were not tested on this item.

One-Arm One-Leg Involvement

The non-impaired leg of the subject was held down by a partner and the impaired leg was supported to the fullest possible extent. Subjects crossed the non-impaired arm and any possible portion of the impaired limb on the chest.

Timed Leg Raise

One-Arm Involvement

Subjects were required to keep one hand in firm contact with the back of their head and neck at all times.

Two-Arm Involvement

Subjects placed arms at a backward angle, similar to the position assumed by the upper arms when the hands clasp the head.

One-Leg Involvement

Subjects raised only one leg.

Two-Leg Involvement

Subjects did not participate in this exercise.

One-Arm One-Leg Involvement

Subjects raised one leg and placed one hand behind their head/neck area during the leg raise.

Timed Trunk Raise

One-Arm Involvement

Subjects were required to keep one hand in contact with the back of the head and neck at all times.

Two-Arm Involvement

Subjects placed upper limbs at a backward angle, similar to the position assumed by the upper arms when the hands clasp the head.

One-Leg Involvement

The non-impaired leg was held down and the impaired leg was stabilized to the fullest possible extent.

Two-Leg Involvement

Subjects were supported on the upper thigh and/or buttocks.

One-Arm One-Leg Involvement

The non-impaired leg was held down at the calf and the impaired leg was held down at the upper thigh and/or buttocks to the fullest possible extent. Subjects placed one hand behind their head/neck area during the trunk raise.

Right and Left Grip Strength

One-Arm Involvement

Subjects performed the test with the non-impaired arm only.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects performed the test with the non-impaired arm only.

Flexed Arm Hang

One-Arm Involvement

Subjects did not participate in this activity.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects did not participate in this activity.

Pull-Ups

One-Arm Involvement

Subjects did not participate in this activity.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

No modifications were considered necessary.

One-Arm One-Leg Involvement

Subjects did not participate in this activity.

Standing Broad Jump

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg Involvement

Subjects were allowed to participate in this activity. If the subject requested arm support during the jump, this assistance was provided.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

Subjects were allowed to participate in this activity. If the subject requested arm support during the jump, this assistance was provided.

Softball Throw

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects performed this activity from a seated position in a straight back chair or wheelchair. Subjects were given adequate warm up and two practice trials. Subjects were instructed to lock their brakes prior to throwing.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Speed

50-Yard/Meter Dash

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who, it was thought, were capable of completing the event in a reasonable period of time (15 seconds or less).

Two-Leg Involvement

Only subjects who used wheelchairs in daily activities were tested. These subjects were tested according to one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, or moved wheelchair backward with feet.

One-Arm One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who, it was thought, were capable of completing the event in a reasonable period of time (15 seconds or less).

Agility

Rise-to-Stand

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Mat Creep

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Shuttle Run

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects were instructed to bend down at the end lines so that one knee touched the running surface. This was repeated until the shuttle run distance was completed (three knee touches and a running finish).

One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who, it was thought, were capable of completing the event in a reasonable period of time (30 seconds or less).

Two-Leg Involvement

This test was administered only to subjects who used a wheelchair for daily activities. This event was completed under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, or moved wheelchair backward with feet. Wheelchair participants wheeled to the wooden blocks which were set up on an inverted wastebasket (size ranging from 15 inches to 25 inches in height). The subject picked up one block and placed it on his/her lap and wheeled back to the starting line. The block then was dropped to the floor behind the starting line. The subject returned to the second block, picked it up off the basket, placed it in the lap, and wheeled as quickly as possible past the start/finish line to complete the shuttle run.

One-Arm One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who were believed to be capable of completing the event in a reasonable period of time (30 seconds or less).

Flexibility

Sit and Reach

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

Subjects did not participate in this activity.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

No modifications were considered necessary.

Cardiorespiratory Function

One Mile/Nine-Minute Run, One-and-One-Half Mile/Twelve-Minute Run

One-Arm Involvement

No modifications were considered necessary.

Two-Arm Involvement

No modifications were considered necessary.

One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who were reasonably capable of participating in this event.

Two-Leg Involvement

Only subjects who used wheelchairs in daily activities were tested. These subjects were tested according to one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, or moved wheelchair backward with feet.

One-Arm One-Leg Involvement

Some subjects did not participate in this activity. This test was administered only to subjects who were reasonably capable of participation in this event.

Static Balance

Modified Stork Test

One-Arm Involvement

Subjects were required to cross the non-impaired arm and any portion of the impaired arm on the chest. The impaired limb was not to be used for balancing purposes.

Two-Arm Involvement

Subjects were required to cross their chest with any portion of impaired limbs they possessed. Subjects were not allowed to extend their upper limbs as balancing aids.

One-Leg Involvement

No modifications were considered necessary.

Two-Leg Involvement

Subjects did not participate in this activity.

One-Arm One-Leg Involvement

Subjects were required to cross the non-impaired arm and any portion of the impaired arm on their chest. The impaired limb was not to be used for balancing purposes.

Participation Guide and Test Modifications for Subjects with Cerebral Palsy

Test modifications for subjects with cerebral palsy are presented in this section. In addition, the participation guide is presented in Table 2.12. The participation guide for subjects with cerebral palsy was developed in conjunction with the 1979 classification system of the National Association of Sports for Cerebral Palsy (NASCP). The eight NASCP classes are defined on Table 2.13 immediately following the participation guide. As evident in the participation guide, the more severely involved subjects with cerebral palsy were tested on fewer items than were less severely involved subjects. Class I subjects, for instance, were only tested on the body composition measures. Many of the modifications employed with subjects with cerebral palsy were designed to improve the stability of the participant, such as in the softball throw, where subjects could lean against the back of a chair or could perform the activities seated. Each test item, with appropriate modification, is discussed separately for subjects with cerebral palsy.

Body Composition

Height and Weight

The height of a subject wearing braces was taken with the brace on. The height of a subject with exaggerated flexor tone (e.g., spastic paraplegic) was recorded as his/her functional standing height (i.e., no attempt was made to relax and straighten affected parts of the body prior to measurement). The height of a wheelchair participant was taken with the subject lying on a mat.

The weight of all subjects was taken with braces removed. Wheelchair participants were weighed without their wheelchairs.

Testers were instructed to omit height and weight measures for wheelchair participants if obtaining these measures posed a safety problem to either the subject or the tester.

Triceps, Subscapular, and Abdominal Skinfolds

Classes I-VII

No modifications were considered necessary.

Muscular Strength/Endurance

Timed Flexed Knee Sit-Ups

Class I

This test was not administered to Class I subjects.

Classes II-VII

No major modifications were considered necessary. Testers attempted to follow regular standardized procedures.

TABLE 2.12. PARTICIPATION GUIDE FOR SUBJECTS WITH CEREBRAL PALSY.

Test	Participation by Subclassification							
	Wheelchair				Ambulant			
	Severe		Minimal		Severe		Minimal	
	I	II	III	IV	VA	VB	VI	VII
1. Body Composition Measures								
Height and Weight	X	X	X	X	X	X	X	X
Triceps Skinfold	X	X	X	X	X	X	X	X
Subscapular Skinfold	X	X	X	X	X	X	X	X
Abdominal Skinfold	X	X	X	X	X	X	X	X
2. Muscular Strength/Endurance								
Sit-Ups		X	X	X	X	X	X	X
Leg Raise		X	X	X	X	X	X	X
Trunk Raise							X	X
Right Grip		X	X	X	X	X	X	X
Left Grip		X	X	X	X	X	X	X
Flexed Arm Hang				X	X	X	X	X
Pull-Ups				X	X	X	X	X
Standing Broad Jump					X		X	X
Softball Throw		X*	X*	X*	X	X	X	X
3. Speed								
50-Yard/Meter Dash		X^{WC}	X^{WC}	X^{WC}	X	X	X	X
4. Agility								
Rise-to-Stand					X		X	X
Mat Creep		X	X	X	X	X	X	X
Shuttle Run		X^{WC}	X^{WC}	X^{WC}	X	X	X	X
5. Flexibility								
Sit and Reach				X	X		X	X
6. Cardiorespiratory Function								
9-Minute/1 Mile Run or 12-Minute/1½ Mile Run				X^{WC}	X	X	X	X
7. Static Balance								
Modified Stork Test							X	X

wc - Only subjects who used a wheelchair for daily activities were testing on this item.

*Subjects performed this item while seated.

TABLE 2.13. NASCP CLASSIFICATION SYSTEM (1979)*

Class I

Individuals who:

A) Are quadriplegic
B) Wheelchair bound, cannot ambulate a long distance without assistance
C) Have poor functional strength and severe control problems in the upper extremities and torso
D) Move their wheelchair with their arms during track events

Class II

Individuals who:

A) Are quadriplegic
B) Wheelchair bound, cannot ambulate without assistance
C) Have poor functional strength and severe control problems in the upper extremities and torso
D) Propel their wheelchair using feet during track events

Class III

Individuals who:

A) Are quadriplegic or triplegic
B) Ambulate with assistive devices without personal assistance and/or need to use a wheelchair at all times or for regular daily activities
C) Have fair functional strength and moderate control problems in the upper extremities and torso
D) Propel wheelchair with arms during track events

Class IV

Individuals who:

A) Are paraplegic or triplegic (two legs and one arm or possible quadriplegic)
B) Ambulate with assistive devices without assistance and/or need to use a wheelchair for convenience in daily activities
C) Have good functional strength and minimal control problems in the upper extremities and torso (upper extremities may have exaggerated reflexes)
D) Move wheelchair with arms during track events

*Adopted from: National Association of Sports for Cerebral Palsy. Constitution, Rules Classification, and National Records Sports Manual. National Association of Sports for Cerebral Palsy, 1979.

TABLE 2.13 (cont.)

Class VA

Individuals who:

A) Are quadriplegic athetoid (or similar involvement)
B) Ambulate without assistive devices during regular daily activities
C) Will compete in track events on their feet without assistive devices
D) Have moderate to severe control problems in all extremities and torso
E) May use a chair for stabilization in non-track events

Class VB

Individuals who:

A) Are spastic paraplegic (or similar involvement)
B) Utilize cane or crutches in regular daily ambulation
C) Will compete in all events on their feet utilizing assistive devices (i.e., canes/crutches)
D) Have good functional strength and minimal control problems in the upper extremities and torso (upper extremities may have exaggerated reflexes)
E) May use a chair for stabilization in non-track events

Class VI

Individuals who:

A) Are quadriparetic athetoid with moderate to minimal control problems
B) Ambulate without assistive devices during daily activities
C) Will compete in track events on their feet without the use of assistive devices
D) Have moderate to minimal control problems in three or all extremities and torso
E) May not use a chair for stabilization in non-track events

Class VII

Individuals who:

A) Are hemi or monoplegic (one arm, possible very minimal quadriplegic)
B) Ambulate without assistive devices during daily activities and are capable of running and jumping freely
C) Will compete in all events on their feet without assistive devices
D) May not use a chair for stabilization in non-track events

Timed Leg Raise

Class I

This test was not administered to Class I subjects.

Classes II-VII

No major modifications were considered necessary. Testers attempted to follow regular standardized procedures.

Timed Trunk Raise

Classes I-VB

This test was not administered to Classes I-VB.

Classes VI and VII

No major modifications were considered necessary. Testers attempted to follow regular standardized procedures.

Right and Left Grip Strength

Class I

This test was not administered to Class I subjects.

Classes II-VII

No major modifications were considered necessary, however, only limbs with functional strength were tested.

Flexed Arm Hang

Classes I-III

This test was not administered to Classes I-III.

Classes IV-VII

This test was administered without modification to the fullest possible extent. Where arm involvement prohibited grasping the bar, the bearing of weight or reasonable execution, this item was omitted.

Pull-Ups

Classes I-III

This test was not administered to Classes I-III.

Classes IV-VII

This test was administered without modification to the fullest possible extent. Where arm involvement prohibited grasping the bar, the bearing of weight, or reasonable execution, this item was omitted.

Standing Broad Jump

Classes I-IV

This test was not administered to Classes I-IV.

Class VA

This test was administered without major modification. If the subject requested arm support during the jump, this assistance was provided.

Class VB

This test was not administered to Class VB subjects.

Classes VI and VII

No modifications were considered necessary.

Softball Throw

Class I

This test was not administered to Class I subjects.

Classes II-IV

Subjects were required to perform the task seated in a wheelchair.

Classes VA and VB

Subjects were allowed to use a chair for stabilization during the softball throw.

Classes VI and VII

No major modifications were considered necessary.

Speed

50-Yard/Meter Dash

Class I

This test was not administered to Class I subjects.

Classes II-IV

Subjects in these classes completed the task in a wheelchair. The test was only administered to subjects who used wheelchairs in daily activities. Subjects propelled their wheelchair either forward or backward using the feet or forward using their arms.

Class VA

Subjects were required to ambulate in this event without assistive devices.

Class VB

Subjects used a cane, crutch, or walker for this test.

Classes VI and VII

No major modifications were considered necessary.

Agility

Rise-to-Stand

Classes I-IV

This test was not administered to Classes I-IV.

Class VA

No major modifications were considered necessary, although it was permissible for subjects to use a chair to balance after attaining the stand.

Class VB

The test was not administered to Class VB subjects.

Classes VI and VII

No modifications were considered necessary.

Mat Creep

Class I

This test was not administered to Class I subjects.

Classes II-VII

No modifications were considered necessary. Any movement to complete the task was permitted. Thus, participants were permitted to crawl.

Shuttle Run

Class I

This test was not administered to Class I subjects.

Classes II-IV

Subjects completed this task in a wheelchair. They propelled their wheelchair either forward or backward using their feet or forward with their arms. Subjects wheeled to the wooden blocks which were set up on an inverted wastebasket (size ranging from 15 inches to 25 inches in height). The subject picked up one block, placed it on his/her lap, and wheeled back to the starting line. The block then was dropped to the floor behind the starting line. The subject returned to the second block, picked it up off the basket, placed it in the lap, and wheeled as quickly as possible past the start/finish line to complete the shuttle run.

Classes VA and VB

Instead of picking up blocks from the floor, subjects picked up blocks from an inverted wastebasket (size ranging from 15 inches to 25 inches in height). The subject picked up one block and ran back to the starting line, dropped the block behind the starting line, returned to the second block, picked it up off the basket, and ran as quickly as possible past the start/finish line to complete the shuttle run.

Classes VI and VII

No modifications were considered necessary.

Flexibility

Sit and Reach

Classes I-III

This test was not administered to Classes I-III.

Classes IV and VA

No modifications were considered necessary.

Class VB

This test was not administered to Class VB subjects.

Classes VI and VII

No modifications were considered necessary.

Cardiorespiratory Function

One Mile/Nine-Minute Run, One-and-One-Half Mile/Twelve-Minute Run

Classes I-III

This test was not administered to Classes I-III.

Class IV

Subjects in this classification were required to use a wheelchair for this event and to propel it forward with their arms.

Class VA

Subjects were required to ambulate in this event without assistive devices.

Class VB

Subjects used a cane, crutches, or a walker for this test.

Classes VI and VII

Subjects were required to ambulate in this event without assistive devices.

Static Balance

Modified Stork Test

Classes I-VB

This test was not administered to Classes I-VB.

Classes VI and VII

No modifications were considered necessary.

Participation Guide and Test Modifications for Subjects with Spinal Neuromuscular Conditions

Test modifications for subjects with spinal neuromuscular conditions are presented in this section. In addition, the participation guide is presented in Table 2.14. The participation guide used for subjects with spinal neuromuscular conditions was developed in conjunction with the classification system of the National Wheelchair Athletic Association (NWAA). The NWAA system can be found in Table 2.15 immediately following the participation guide; however, for the purposes of test selection, testers needed only to determine whether the subject was quadriplegic or paraplegic. Paraplegic subjects participated in a greater number of test items. The test items for subjects with spinal neuromuscular conditions generally were modified to allow for wheelchair participation. Each test item with appropriate modification is discussed separately for subjects with spinal neuromuscular conditions.

Body Composition

Height and Weight

The height of a subject wearing braces was taken with the braces on. The height of a wheelchair participant was taken with the subject lying on a mat, if possible.

The weight of all subjects was taken with braces removed. Wheelchair participants were weighed without their wheelchairs.

Testers were instructed to omit height and weight measures for wheelchair participants if obtaining these measures posed a safety problem to either the subject or the tester.

Triceps, Subscapular, and Abdominal Skinfolds

Quadriplegic and Paraplegic Involvement

Some subjects needed to be supported while skinfold measurements were being taken. Abdominal and subscapular measures were taken from a seated position.

Muscular Strength/Endurance

Sit-Ups, Leg Raise, Trunk Raise

Quadriplegic and Paraplegic Involvement

Subjects were not tested on these items

Right and Left Grip Strength

Quadriplegic Involvement

Subjects were not tested on these items.

TABLE 2.14. PARTICIPATION GUIDE FOR SUBJECTS WITH SPINAL NEUROMUSCULAR CONDITIONS.

Test	Participation by Subclassification						
	Quadriplegic (Complete or Incomplete)*			Paraplegic or Comparable Disability (Complete or Incomplete)*			
	IA	IB	IC	II	III	IV	V
1. Body Composition Measures							
Height and Weight	X	X	X	X	X	X	X
Triceps Skinfold	X	X	X	X	X	X	X
Subscapular Skinfold	X	X	X	X	X	X	X
Abdominal Skinfold	X	X	X	X	X	X	X
2. Muscular Strength/Endurance							
Sit-Ups							
Leg Raise							
Trunk Raise							
Right Grip				X**	X**	X**	X**
Left Grip				X**	X**	X**	X**
Flexed Arm Hang				X	X	X	X
Pull-Ups				X	X	X	X
Standing Broad Jump							
Softball Throw	X**	X**	X**	X**	X**	X**	X**
3. Speed							
50-Yard/Meter Dash				X^wc	X^wc	X^wc	X^wc
4. Agility							
Rise-to-Stand							
Mat Creep							
Shuttle Run	X^wc	X^wc	X^wc	X^wc	X^wc	X^wc	X^wc
5. Flexibility							
Sit and Reach							
6. Cardiorespiratory Function							
9-Minute/1 Mile Run or 12-Minute/1½ Mile Run	X^wc	X^wc	X^wc	X^wc	X^wc	X^wc	X^wc
7. Static Balance							
Modified Stork Test							

wc - Only subjects who used wheelchairs in daily activities were tested on this item.

*It was not necessary to classify subjects into seven categories. Testers needed only to distinguish the quadriplegic and paraplegic.

**Subjects were tested in a seated position on these items.

TABLE 2.15. NWAA CLASSIFICATION SYSTEM.*

Class IA

All cervical lesions with complete or incomplete quadriplegia who have involvement of upper extremities, weakness of triceps (up to and including grade 3 on the testing scale) and with severe weakness of the trunk and lower extremities interfering significantly with trunk balance and the ability to walk.

Class IB

All cervical lesions with complete or incomplete quadriplegia who have involvement of upper extremities but less than IA with preservation of normal or good triceps (4 or 5 testing scale) and with a generalized weakness of the trunk and lower extremities interfering significantly with trunk balance and the ability to walk.

Class IC

All cervical lesions with complete or incomplete quadriplegia who have involvement of upper extremities but less than IB with preservation of normal or good triceps (4 or 5 on testing scale) and normal or good finger flexion and extension (grasp and release) but without intrinsic hand function and with a generalized weakness of the trunk and lower extremities interfering significantly with trunk balance and the ability to walk.

Class II

Complete or incomplete paraplegia below T1 down to and including T5 or comparable disability with total abdominal paralysis or poor abdominal muscle strength (0-2 on testing scale) and no useful trunk sitting balance.

Class III

Complete or incomplete paraplegia or comparable disability below T5 down to and including T10 with upper abdominal and spinal extensor musculature sufficient to provide some element of trunk sitting balance but not normal.

Class IV

Complete or incomplete paraplegia or comparable disability below T10 down to and including L2 without quadriceps or very weak quadriceps with a value up to and including 2 on the testing scale, and gluteal paralysis.

Class V

Complete or incomplete paraplegia or comparable disability below L2 with quadriceps in grades 3-5.

*Adopted from: National Wheelchair Athletic Association: Constitution and Rules, Training Techniques and Records. National Wheelchair Athletic Association, 40-24 62nd Street, Woodside, N.Y., 11377.

Paraplegic Involvement

Subjects were allowed to be tested in their wheelchairs.

Flexed Arm Hang and Pull-Ups

Quadriplegic Involvement

Subjects were not tested on these items.

Paraplegic Involvement

Where possible, bars were lowered so that wheelchair participants could pull themselves out of their wheelchairs for these items, otherwise subjects were lifted to the bar. Careful spotting was employed at all times.

Standing Broad Jump

Quadriplegic Involvement

Subjects were not tested on this item.

Paraplegic Involvement

Subjects did not participate on this item.

Softball Throw

Quadriplegic and Paraplegic Involvement

Subjects in wheelchairs were tested on the softball throw from a seated position. Subjects in wheelchairs were instructed to lock their brakes prior to throwing.

Speed

50-Yard/Meter Dash

Quadriplegic Involvement

Subjects were not tested on this item.

Paraplegic Involvement

Subjects completed the 50-yard/meter dash in a wheelchair under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, or moved wheelchair backward with feet. Only subjects who used a wheelchair for daily activities were tested.

Agility

Rise-to-Stand and Mat Creep

Quadriplegic and Paraplegic Involvement

Subjects were not tested on these items.

Shuttle Run

Quadriplegic and Paraplegic Involvement

Subjects who used a wheelchair for daily activities participated in the shuttle run using this method of ambulation. The subject wheeled to the two wooden blocks which were set up on an inverted wastebasket (size ranging from 15 inches to 25 inches in height). The subject picked up one block, placed it on his/her lap, and wheeled back to the starting line. The block then was dropped to the floor behind the starting line. The subject returned to the second block, picked it up off the basket, placed it in their lap, and wheeled as quickly as possible past the start/finish line to complete the shuttle run.

Flexibility

Sit and Reach

Quadriplegic and Paraplegic Involvement

Subjects were not tested on this item.

Cardiorespiratory Function

One Mile/Nine-Minute Run, One-and-One-Half Mile/Twelve-Minute Run

Quadriplegic and Paraplegic Involvement

Subjects who participated in this test utilized a wheelchair. Only subjects who used a wheelchair for their daily activities were tested. The test was conducted under one of the following conditions: moved wheelchair forward with arms, moved wheelchair forward with feet, or moved wheelchair backward with feet.

Static Balance

Modified Stork Test

Quadriplegic and Paraplegic Involvement

Subjects were not tested on this item.

Data Recording and Review

Project UNIQUE testers were provided with two forms for the purpose of data recording--data sheets and scan sheets. Data sheets were used in the field during the actual conduct of testing. Data sheets provided clearly labeled areas for demographic and performance information. The units of measure (feet, seconds, etc.) for each test item were also specified. Testers were instructed to compute all averages and conversions (i.e., feet to inches) on the data sheets.

Once the data sheets were completed, testers transferred the demographic and performance data to computer scan sheets. As with the data sheets, the scan sheets clearly labeled required information and presented units of measurement to facilitate data transfer. Testers were instructed to submit both the data sheets and scan sheets to project personnel in Brockport.

When the data arrived at the SUNY, College at Brockport, they were carefully reviewed by project staff. All averages and data conversions were checked individually. Also, data from each test site were entered into the computer, analyzed as grouped data, and the printout reviewed for additional errors. In instances where questions arose concerning the validity of the data, testers were contacted and the problems discussed. In cases where it was found that test procedures had been violated in some way, the data in question were not included in data analysis. Considerable effort was made to insure that only accurate data were used in the study.

Training Program for Testers

All Project UNIQUE testers were required to participate in the competency-based Project UNIQUE Training Program designed to develop the skills and knowledge necessary to effectively implement the testing protocols of the study. The training program, which required approximately four hours, presented the overview and scope of the study; the organizational structure for data collection; definitions and classifications of subjects; a description of test items and how they were administered; test modifications; sampling procedures; an explanation of unique testing equipment and supplies; and methods of data recording. Field testers were provided with a 158-page manual detailing this information which testers could take with them and use as a reference as they performed their duties as field testers. Each training session was conducted by a trainer who had previously attended a training session, demonstrated the required competencies, and was considered qualified to train others in the procedures of the study. Trainers were provided and followed an outline of the training program to standardize training procedures.

The purpose of the training session was to provide testers with the following competencies:

1. Understand the purposes and general procedures of Project UNIQUE.

2. Understand the purpose of each test item.

3. Understand the specific testing procedures for normal and impaired populations.

4. Understand the specific test modifications for the various impaired populations.

5. Demonstrate the ability to set up and utilize unfamiliar pieces of equipment to be used for data collection.

6. Demonstrate the ability to record data accurately on the data recording sheet.

7. Demonstrate the ability to accurately transfer and code data from the data recording sheet to the scan sheet.

8. Understand the sampling procedures to be employed in subject selection.

To determine whether competencies had been attained, two types of evaluations were required of trainees. First, trainees were required to demonstrate test related skills at the conclusion of the training session. This demonstrative evaluation required accurate completion of Project UNIQUE score sheets, accurate transfer of data to Project UNIQUE scan sheets, and appropriate administration of the skinfold test, the sit and reach test, and the grip strength test. The ability to administer the skinfold test, the sit and reach test, and the grip strength test was evaluated because it was felt these tests were relatively unfamiliar to many professionals. Trainees were graded on a 50-point scale during their demonstrative evaluation. Points were awarded as follows:

Demonstrative Evaluation

Competency	Points
Data Recording Capability (score sheets)	16
Data Transfer Capability (scan sheets)	16
Skinfold Assessment	6
Sit and Reach Assessment	6
Grip Strength Assessment	6
	50

In evaluating data recording and data transfer capabilities, score sheets and scan sheets were divided into eight sections. Trainees received two points for each section where data were accurately recorded or transferred. The data were provided by the trainer. For the test administration competencies, specific criteria were listed. These competencies are given below:

Skinfold Competencies

1. Proper identification of the abdominal area.
2. Proper identification of the triceps area.
3. Proper identification of the subscapular area.
4. Separation of skinfold from muscle tissue.
5. Proper placement of guide dots for measurement.
6. Reliability in measures (less than 5 percent error).

Sit and Reach Competencies

1. Subject placed in a seated position, legs extended on mat.
2. Subject's shoes removed, knees held down, feet flush against apparatus.
3. Subject advised not to bob before reaching.
4. Tester begins activity properly with hand/verbal signal.
5. Reach held for one second while score is recorded.
6. Score recorded accurately to nearest centimeter.

Grip Strength Competencies

1. Testing instructions performed properly.
2. Hand dynamometer adjusted so that handle is gripped with fingers (second joint) and the heel of the hand is placed at the base of the dynamometer with the thumb wrapped around the base.
3. Subject seated properly with arms free from the chair.
4. Activity begun properly with hand/verbal signal. Hands alternated during test trials.
5. Score recorded accurately (trials and mean).
6. Each subject provided three trials, alternating with each hand.

The second type of evaluation required of trainees was the completion of a written examination. This written evaluation consisted of 50 multiple choice questions related to the purpose of the project, general test procedures, general test instructions, specific test modifications, and sampling procedures. Trainees were asked to submit answers to the written evaluation some time after the completion of the training session and before their scheduled date to begin testing. The written evaluation was also based on a 50-point scale. Points were awarded as follows:

Written Evaluation

Competency	Number of Questions/Points
Purpose of the Project	3
General Test Procedures	14
General Test Instructions	14
Specific Test Modifications	14
Sampling Procedures	5
	50

The complete training program evaluation was worth 100 points. Trainees were required to attain a score of at least 90 points prior to testing subjects. Those trainees failing to score at least 90 points were given additional opportunities to achieve the necessary score.

Trend Analysis and Test Reliability

Daquila (1982), in an unpublished Master's Thesis, investigated the trend analysis and test reliability of all multiple-trial Project UNIQUE test items (skinfolds, rise-to-stand, mat creep, shuttle run, stork test, sit and reach, grip strength, flexed arm hang, broad jump, and softball throw) and two single-trial test items--timed leg raise and timed trunk raise. To analyze multiple-trial items (all trials were administered on the same day), Daquila randomly selected 50 Project UNIQUE subjects from each of the major subject categories (normal, auditory impaired, visually impaired, and orthopedic impaired). To provide data for the two single-trial items, Daquila tested 50 normal, 50 auditory impaired, and 47 visually impaired subjects. Orthopedically impaired subjects were not included in this aspect of the study since the timed leg raise and timed trunk raise were generally not administered to these subjects. Three trials were administered for both the timed leg raise and timed trunk raise to each subject during consecutive physical education class periods (two to three days between trials).

Daquila computed repeated measures analysis of variance (for trend analysis), Cronbach's alpha coefficient (for reliability), and the standard error of measurement (for variability) for each item in each major subject group. In some instances, especially in the orthopedic group, it was necessary to compute these analyses with a sample size of less than 50. The results of these analyses are presented in Table 2.16.

The results presented in Table 2.16 indicate that, in most cases, the data were trend free, i.e., a repeated measures analysis of variance did not yield a significant trials effect at the .05 level. A significant trend emerged for sit and reach (all groups), shuttle run (normal group), mat creep (normal group), broad jump (visually impaired group), right and left grip strength (normal and auditory impaired groups), and left grip strength (orthopedically impaired group). With the exception of grip strength, performance generally improved on subsequent trials in those cases where trend was present. Effects of learning and/or warm-up may have influenced performance on those items. Fatigue was apparently a factor during grip strength in most, but not all, subject categories, as performance generally declined on subsequent trials.

Generally, the alpha coefficients presented in Table 2.16 are high, with the majority above .90. Three coefficients are in the .70's and only two are below .70. The reliability coefficients presented in Table 2.16, in general, are higher than those found in other studies for similar items. The item most unreliable appears to be the modified stork test. While three of the four alphas are at least minimally acceptable (above .70), the standard errors of measurement are relatively large indicating that, although subjects generally maintained their rank in the group, there can be little confidence that the mean closely approximates a subject's true score. Despite generally acceptable alphas, therefore, the mean score for the stork test may not truly represent the subject's performance on the test.

The lowest calculated alpha was associated with the rise-to-stand for the normal group (.40). This low alpha may be attributed to the short period of time in which the item was completed (which may have contributed to measurement error), and the low range of scores obtained for normal subjects (which may have reduced the reliability coefficient). Rise-to-stand, however,

TABLE 2.16. MEANS, STANDARD ERRORS OF MEASUREMENT, AND ALPHA COEFFICIENTS OF PROJECT UNIQUE RELIABILITY SAMPLES.

Test Items	# of Trials	Normal				Visual				Auditory				Orthopedic			
		N	X	SEM	a	N	X	SEM	a	N	X	SEM	a	N	X	SEM	a
Triceps Skinfold	3	50	12.72	.33	.99	50	13.75	1.04	.97	50	12.49	.78	.98	50	12.70	.85	.97
Abdominal Skinfold	3	50	14.14	.54	.99	50	16.68	2.66	.90	50	13.74	.91	.98	49	13.93	.53	.99
Subscapular Skinfold	3	50	10.29	.36	.99	50	13.84	.60	.99	50	10.45	.44	.99	50	10.64	.35	.99
Rise-to-Stand	3	50	1.38	.38	.40	50	1.88	.22	.91	50	1.67	.16	.90	25	4.39	.51	.93
Mat Creep	3	50	3.56*	.15	.85	50	4.42	.23	.97	50	3.86	.20	.96	41	10.23	1.22	.97
Shuttle Run	2	50	11.31*	.46	.86	50	12.49	.68	.92	50	11.95	2.48	.70	50	34.77	2.04	.99
Stork Test	3	50	46.96	26.92	.89	50	17.15	10.06	.77	50	9.89	7.52	.76	22	2.42	2.86	.61
Sit and Reach	2	50	29.19*	.95	.99	50	23.22*	1.15	.98	50	22.95*	.94	.99	38	20.93*	.97	.99
Right Grip	3	50	24.01*	1.08	.98	50	23.53	1.14	.99	50	23.42*	1.36	.97	50	14.15	1.33	.98
Left Grip	3	50	22.36*	1.04	.98	50	21.17	1.69	.97	50	21.01*	1.21	.98	50	14.86*	1.00	.99
Arm Hang	2	50	8.35	2.88	.93	50	11.48	4.85	.84	50	9.17	3.11	.92	50	2.50	1.08	.96
Broad Jump	3	50	5.27	.18	.96	50	4.96*	.29	.94	50	5.08	.16	.98	21	2.04	.16	.99
Softball Time	3	50	2.13	.24	.84	50	1.88	.26	.88	50	2.03	.22	.88	49	1.05	.14	.94
Softball Distance	3	50	92.39	7.62	.95	50	70.71	4.35	.99	50	84.73	4.11	.99	50	28.91	4.51	.86
Leg Raise[1]	3	50	40.52	9.53	.83	47	41.99	11.34	.91	50	53.93	9.12	.93	- - - - - - - - - - - -			
Trunk Raise[1]	3	50	61.35	13.33	.91	46	47.75	4.57	.99	50	59.37	11.40	.91	- - - - - - - - - - - -			

*Significant trend present in the data

[1]2-3 days between trials

N - Number of subjects in analysis

X - Mean Score

SEM - Standard Error of Measurement

a - alpha coefficient

Daquila, Gene A. "Reliability of Selected Health and Performance Related Test Items from the Project UNIQUE Physical Fitness Test Battery." Unpublished Master's Thesis, SUNY College at Brockport, 1982.

was found to be reliable for the visual, auditory, and orthopedic groups (alphas of .90 or above).

It should be noted that use of the Cronbach alpha is most appropriate for repeated measures when the data are trend free. The alpha coefficients presented in Table 2.16, however, were calculated using all trials. This procedure was followed because at least two trials are required to compute alpha and the number of trials must be sufficient to determine a trend-free schedule. Only two trials were administered for the sit and reach and shuttle run tests, thus requiring all trials to be included in the computation of the alpha coefficient for those items. In the two instances where mat creep and broad jump demonstrated significant trends, the number of trials were insufficient to determine a trend-free schedule. For those cases where grip strength evidenced significant trend, a second set of alphas was calculated using trials one and two only. (Trial three was eliminated because it was significantly different than either trial one or trial two in each instance.) Table 2.17 contrasts the means and alpha coefficients for the two-trial schedule with the means and alpha coefficients calculated using all trials.

TABLE 2.17. MEANS AND ALPHA COEFFICIENTS OF GRIP STRENGTH TESTS WITH SIGNIFICANT TREND CATEGORIZED BY MEASUREMENT SCHEDULE.

	Trials 1, 2, & 3		Trials 1 & 2	
	$\bar{X}$	a	$\bar{X}$	a
Right Grip				
Non-Impaired	24.01	.98	24.28	.96
Auditory Impaired	23.42	.97	23.85	.95
Left Grip				
Non-Impaired	22.36	.98	22.76	.98
Auditory Impaired	21.01	.98	21.25	.98
Orthopedically Impaired	14.86	.99	15.29	.99

The data presented in Table 2.17 demonstrate that modifying the measurement schedule does not appreciably affect the reliability of the test. The grip strength test can be considered very reliable for each subject category regardless of the measurement schedule employed. Project UNIQUE employs the three trial schedule so that test procedures are consistent for all disability classifications.

Excluding height and weight, four single trial test items were not included in Daquila's reliability study. These items were as follows: sit-ups, pull-ups, 50-yard/meter dash, and long distance run. Previous research has shown these items to possess satisfactory reliability (refer to Chapter V for detailed information).

Equipment

With the exception of a hand dynamometer, skinfold caliper, and a sit and reach apparatus, the equipment employed in this study was typically found in physical education programs. Specific equipment needed to administer a particular test is identified in an earlier section of this chapter. Hand dynamometers, skinfold calipers, and sit and reach pieces of equipment were provided by the project. To help assure proper functioning of their instruments, field testers were asked, upon receiving test equipment, to check it for damage, obvious malfunction, and performance according to standards identified for the project. If equipment was damaged and standards were not met, field testers were asked to return the quipment to Brockport.

The hand dynamometer selected for this study was the Smedley-type distributed by the J.A. Preston Corporation. The dynamometer consisted of a metal frame with an adjustable stirrup on the handgrip. The minimal accuracy accepted for using the instrument for testing was ± 5 kg., using an 18 kg. weight as a reference. This standard, unfortunately, allowed considerable error in measurement, but was required since the instrument appeared to be incapable of greater accuracy.

The Lange skinfold caliper was selected as the fat caliper to be used in the study. This caliper meets the 10 grams per square millimeter standard generally subscribed to in research investigations. Upon receipt from the distributor (Cambridge Scientific Industries), the Lange skinfold calipers were checked by the Project UNIQUE staff and were considered acceptable if they were within ± 10 percent when measuring standard widths throughout their range of measurements. The Lange skinfold calipers were well within this standard and were found to be very reliable.

The sit and reach pieces of equipment were constructed locally using plywood (see Figure 2.13). The top panel was marked with one centimeter gradations with the 23 centimeter line exactly in line with the vertical panel against which the subjects' feet were placed. Each sit and reach apparatus was checked to determine whether specifications were met and were subsequently mailed to testers.

CHAPTER III

PHYSICAL FITNESS PERFORMANCE AND PERFORMANCE FACTORS

Introduction

This chapter presents performance scores of subjects on Project UNIQUE test items, compares performance of different classes of subjects, and analyzes selected factors which have been hypothesized to affect performance. The first part of the chapter presents means and standard deviations on Project UNIQUE test items which have been obtained by normal subjects and subjects with visual impairments, auditory impairments, amputations and congenital anomalies, cerebral palsy, and spinal neuromuscular impairments. Means and standard deviations are presented for each test item, at each age (10 to 17), for males and females and for sexes combined.

The second major section of this chapter presents and analyzes the effects of groups/conditions, age, and sex on physical fitness test performance. The approach used is to present this analysis in three subsections. In the first, individuals with auditory and visual impairments are contrasted with each other and with the normal subjects for each test item. In the next subsection, the cerebral palsy sample is compared with the normal sample for each test item. Finally, normal individuals and subjects with spinal neuromuscular conditions are contrasted. Multivariate and univariate analyses of variance were used to investigate performance differences as a function of subject groups/conditions, sex, and age.

The third major section of this chapter analyzes the effects of severity and onset of handicapping condition and methods of ambulation on physical fitness test performance. Multivariate and univariate analyses of variance and covariance were used to investigate the significance of age of onset of handicapping condition (visually impaired group only), methods of ambulation (visually impaired and cerebral palsy groups only), and community size or educational environment.

The final section of this chapter presents descriptive information pertaining to the magnitude of differences between individuals with handicapping conditions and normal subjects (expressed in standard deviation units) on physical fitness test items, the variability of performance on test items, and the percent of subjects with handicapping conditions scoring higher than median values of normal subjects on Project UNIQUE Physical Fitness Test items.

Means and standard deviations are presented for all test items originally selected for the study. Further analyses, however, were performed on selected items only. Sum of the skinfolds and sum of the grip strengths were not analyzed further since the items which comprised these variables were analyzed separately. Rise-to-stand and stork test were excluded from further analysis due to low reliability. Fifty-meter dash and softball throw for velocity were not analyzed further due to their close relationship to other variables in the study (50-yard dash and softball throw for distance).

Descriptive statistics were calculated for subjects with congenital anomalies and amputations and these results are presented in this chapter. Due to the relatively low number of subjects in this group (N=62), however, no attempt was made to analyze these data using inferential techniques.

Means and Standard Deviations of Project UNIQUE Physical Fitness Test Items

As was mentioned above, the first section of this chapter presents means and standard deviations of Project UNIQUE test items obtained by the major subgroups involved in the study. In the subsequent tables, information is presented for each test item originally selected for the study. Information is specifically given for males and females at each age from 10 to 17. Information presented in regard to individuals with amputations and congenital anomalies is combined, i.e., it is not separated by these conditions. Means and standard deviations presented relative to individuals with spinal neuromuscular impairments must be carefully considered. Data which are presented relative to skinfold and softball test items includes all subjects classified as spinal neuromuscular. Means and standard deviations presented relative to grip strength, flexed arm hang, and pull-ups includes all subjects classified as spinal neuromuscular except for quadriplegics. Data pertaining to the 50-yard and 50-meter dashes, the shuttle run, and long distance run include only subjects classified as spinal neuromuscular and who performed these test items in wheelchairs.

TABLE 3.1. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON NORMAL INDIVIDUALS.

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Tricep Skinfold (mm.)	10	11.9	6.2	61	12.9	5.7	69	12.4	5.9	130
	11	9.4	6.0	45	11.8	4.1	60	10.8	5.1	105
	12	12.9	6.5	100	13.8	5.3	82	13.3	6.0	182
	13	14.8	6.8	126	13.4	6.6	48	14.4	6.8	174
	14	15.4	7.7	130	11.0	4.3	33	14.5	7.3	163
	15	14.6	6.6	63	12.9	4.7	56	13.8	5.8	119
	16	14.2	6.9	67	11.2	4.0	69	12.7	5.8	136
	17	12.0	5.9	24	11.4	5.7	34	11.6	5.7	58
	Entire	13.8	7.0	616	12.5	5.2	451	13.2	6.3	1067
Abdominal Skinfold (mm.)	10	11.7	7.0	61	10.5	6.3	68	11.1	6.6	129
	11	10.0	6.6	45	9.7	5.0	60	9.8	5.7	105
	12	13.7	9.0	99	12.5	6.1	81	13.2	7.8	180
	13	16.1	8.2	125	13.5	9.1	48	15.4	8.5	173
	14	17.2	9.1	130	11.0	6.2	33	16.0	8.9	163
	15	14.5	8.3	63	14.2	8.7	56	14.3	8.5	119
	16	12.7	6.8	67	11.3	4.5	69	12.0	5.7	136
	17	12.4	6.9	24	12.8	5.2	34	12.6	5.9	58
	Entire	14.4	8.4	614	11.9	6.6	449	13.3	7.8	1063
Subscapular Skinfold (mm.)	10	9.4	4.8	61	9.1	5.3	69	9.2	5.1	130
	11	8.4	5.1	45	8.1	3.7	60	8.2	4.3	105
	12	10.1	5.0	99	9.9	4.4	82	10.0	4.8	181
	13	12.4	6.3	125	10.9	7.2	47	12.0	6.6	172
	14	12.6	6.2	130	10.1	4.8	33	12.1	6.0	163
	15	11.5	5.8	63	11.3	4.4	56	11.4	5.2	119
	16	10.8	4.4	67	10.3	3.8	69	10.5	4.1	136
	17	10.2	5.3	24	12.1	4.8	34	11.3	5.1	58
	Entire	11.1	5.7	614	10.0	4.9	450	10.7	5.4	1064
Sum of Triceps and Subscapular Skinfolds (mm.)	10	21.3	10.6	61	22.0	10.5	69	21.7	10.5	130
	11	17.8	10.5	45	19.9	7.1	60	19.0	8.7	105
	12	23.0	11.2	99	23.7	9.1	82	23.3	10.3	181
	13	27.2	12.6	125	24.2	13.3	47	26.4	12.8	172
	14	28.1	13.1	130	21.1	8.0	33	26.7	12.6	163
	15	26.0	11.3	63	24.2	8.3	56	25.2	10.0	119
	16	25.0	10.1	67	21.5	7.3	69	23.2	8.9	136
	17	22.2	9.8	24	23.4	10.0	34	22.9	9.9	58
	Entire	24.9	12.0	614	22.5	9.3	450	23.9	11.0	1064

TABLE 3.1. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit-Ups	10	32.9	7.4	70	35.6	7.8	76	34.3	7.7	146
(no.)	11	32.4	9.5	62	38.7	10.2	69	35.7	10.3	131
	12	35.0	8.6	114	39.7	10.3	92	37.1	9.7	206
	13	36.6	8.5	131	40.7	10.3	53	37.8	9.2	184
	14	34.2	9.0	132	46.6	6.7	37	36.9	10.0	169
	15	36.7	10.8	64	47.8	8.6	58	42.0	11.3	122
	16	35.9	10.9	71	46.3	9.2	69	41.1	11.3	140
	17	34.8	11.9	28	41.3	12.5	36	38.5	12.6	64
	Entire	34.9	9.3	672	41.6	10.3	490	37.7	10.3	1162
Leg Raise	10	26.0	19.2	68	32.2	23.7	77	29.3	21.8	145
(sec.)	11	28.3	21.9	59	32.9	24.2	68	30.7	23.2	127
	12	33.2	20.7	108	35.8	29.9	90	34.4	25.3	198
	13	32.8	24.7	131	36.9	23.3	51	33.9	24.3	182
	14	35.5	27.9	132	48.6	29.8	37	38.4	28.7	169
	15	45.1	36.3	62	61.5	41.0	59	53.1	39.4	121
	16	43.3	30.8	68	56.4	34.0	72	50.0	33.0	140
	17	39.6	30.5	30	59.1	40.7	36	50.3	37.5	66
	Entire	34.9	26.8	658	43.7	32.7	490	38.6	29.8	1148
Trunk Raise	10	49.2	41.6	64	44.2	35.4	72	46.5	38.4	136
(sec.)	11	54.3	39.3	61	56.6	47.3	66	55.5	43.4	127
	12	44.8	34.8	106	46.1	30.8	89	45.4	33.0	195
	13	43.8	31.2	129	52.1	32.2	51	46.1	31.6	180
	14	47.9	32.1	126	52.5	28.1	37	49.0	31.2	163
	15	57.9	35.8	63	45.4	32.0	56	52.0	34.5	119
	16	60.3	37.6	69	54.8	40.2	69	57.6	38.9	138
	17	64.9	40.4	28	48.1	29.2	34	55.7	35.5	62
	Entire	50.3	35.9	646	49.8	35.7	474	50.1	35.8	1120
Right Grip	10	12.2	4.5	62	15.8	4.8	61	14.0	5.0	123
(kg.)	11	15.0	5.1	47	18.2	5.0	44	16.5	5.3	91
	12	19.3	6.0	92	20.9	4.3	63	19.9	5.4	155
	13	21.9	6.4	130	26.5	8.9	53	23.2	7.5	183
	14	24.1	6.7	132	34.2	9.5	38	26.4	8.5	170
	15	28.1	6.2	64	41.0	9.2	57	34.2	10.1	121
	16	28.5	6.2	68	45.1	9.0	68	36.8	11.3	136
	17	27.1	6.7	28	44.9	10.1	34	36.9	12.4	62
	Entire	22.1	7.9	623	30.4	13.8	418	25.4	11.4	1041

TABLE 3.1. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Left Grip (kg.)	10	10.4	4.4	62	14.1	4.4	61	12.2	4.7	123
	11	13.3	4.6	46	16.4	4.3	43	14.8	4.7	89
	12	17.0	6.0	92	18.0	4.7	63	17.4	5.5	155
	13	19.7	6.8	130	22.4	9.4	53	20.5	7.7	183
	14	20.2	5.9	132	30.1	10.0	38	22.4	8.1	170
	15	24.4	6.1	64	38.0	8.1	57	30.8	9.8	121
	16	25.1	5.2	68	41.3	8.9	68	33.2	10.9	136
	17	23.6	6.7	28	39.5	9.4	34	32.3	11.4	62
	Entire	19.3	7.3	622	27.2	13.1	417	22.4	10.7	1039
Sum of Grips (kg.)	10	22.6	8.5	62	29.9	8.8	61	26.2	9.4	123
	11	28.3	9.5	46	34.6	9.0	43	31.4	9.7	89
	12	36.2	11.6	92	38.9	8.6	63	37.3	10.5	155
	13	41.6	12.7	130	48.8	18.0	53	43.7	14.7	183
	14	44.3	12.0	132	64.3	19.0	38	48.8	16.1	170
	15	52.5	11.8	64	79.0	16.9	57	65.0	19.5	121
	16	53.6	10.8	68	86.4	17.4	68	70.0	21.9	136
	17	50.8	12.8	28	84.4	18.9	34	69.2	23.5	62
	Entire	41.4	14.7	622	57.7	26.6	417	47.9	21.9	1039
Arm Hang (sec.)	10	10.1	12.1	69	16.9	22.9	72	13.6	18.7	141
	11	12.7	13.9	56	23.5	25.6	64	18.5	21.5	120
	12	10.6	13.0	104	18.3	16.5	79	13.9	15.0	183
	13	7.0	8.4	130	24.0	27.1	49	11.6	17.5	179
	14	7.4	8.2	132	13.2	8.4	34	8.6	8.5	166
	15	8.9	8.2	63	18.6	11.7	57	13.5	11.1	120
	16	8.8	11.3	67	22.9	11.9	69	15.9	13.6	136
	17	5.2	7.6	30	18.7	11.3	34	12.4	11.8	64
	Entire	8.8	10.6	651	19.8	18.9	458	13.3	15.6	1109
Pull-Ups (no.)	10	1.2	2.3	67	2.2	2.3	77	1.7	2.3	144
	11	1.4	2.6	59	3.1	3.0	67	2.3	2.9	126
	12	1.0	1.5	104	3.0	2.9	89	1.9	2.5	193
	13	0.6	1.5	128	3.7	3.1	51	1.5	2.5	179
	14	0.4	1.2	125	4.6	3.3	27	1.2	2.4	152
	15	0.9	2.4	62	5.3	3.8	57	3.0	3.8	119
	16	0.6	1.4	66	7.0	3.7	68	3.9	4.3	134
	17	0.7	1.1	31	6.2	4.2	36	3.6	4.2	67
	Entire	0.8	1.8	642	4.2	3.6	472	2.2	3.2	1114

TABLE 3.1. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Broad Jump (inches)	10	52.3	6.9	70	59.0	7.1	74	55.7	7.7	144
	11	54.8	8.6	60	63.3	8.1	65	59.2	9.4	125
	12	60.0	8.5	100	62.8	8.5	79	61.2	8.6	179
	13	61.5	9.2	130	67.3	8.7	52	63.2	9.4	182
	14	62.7	10.0	127	74.1	10.4	35	65.1	11.1	162
	15	63.8	8.3	63	81.3	9.5	58	72.2	12.5	121
	16	64.4	9.8	68	82.4	10.6	71	73.6	13.6	139
	17	63.2	11.8	31	81.1	12.3	37	73.0	15.0	68
	Entire	60.5	9.8	649	70.3	13.0	471	64.6	12.3	1120
Softball Distance (inches)	10	576.3	187.7	68	997.1	237.2	74	795.6	300.7	142
	11	583.2	231.9	45	1094.4	248.2	57	868.9	350.2	102
	12	823.5	328.9	78	1211.9	342.8	57	987.5	385.1	135
	13	874.1	319.2	119	1427.8	463.8	42	1018.5	435.6	161
	14	856.4	333.6	125	1640.9	407.4	35	1028.0	477.6	160
	15	938.5	292.3	63	1935.0	403.5	60	1424.6	610.2	123
	16	898.5	292.0	50	1876.3	574.1	72	1475.6	679.0	122
	17	995.3	328.1	26	2040.8	600.1	30	1555.4	718.0	56
	Entire	820.0	323.9	574	1487.3	565.1	427	1104.6	552.4	1001
Softball Velocity (feet per second)	10	41.5	5.7	30	52.3	7.4	35	47.3	8.6	65
	11	41.8	3.4	7	57.0	8.1	26	53.7	9.6	33
	12	51.5	12.4	59	62.2	10.1	36	55.5	12.6	95
	13	50.6	11.3	96	62.3	9.9	16	52.3	11.8	112
	14	47.9	9.2	111	64.8	8.4	23	50.8	11.1	134
	15	50.3	9.4	44	71.5	7.9	49	61.5	13.7	93
	16	50.4	8.2	31	70.2	12.4	55	63.1	14.6	86
	17	63.5	17.5	2	71.4	12.0	13	70.3	12.4	15
	Entire	49.1	10.4	380	64.6	11.8	253	55.3	13.3	633
50-Yard Dash (sec.)	10	9.2	0.9	69	8.5	0.8	75	8.8	0.9	144
	11	8.9	1.1	58	8.2	0.8	69	8.5	1.0	127
	12	8.3	0.8	104	8.2	0.9	90	8.3	0.8	194
	13	8.3	0.9	130	7.7	0.8	50	8.1	0.9	180
	14	8.4	1.7	125	6.8	0.8	33	8.1	1.7	158
	15	8.3	1.3	63	6.7	0.6	60	7.5	1.3	123
	16	8.2	1.4	61	6.8	0.6	74	7.4	1.3	135
	17	8.3	1.2	28	7.1	1.1	33	7.7	1.3	61
	Entire	8.4	1.2	638	7.6	1.1	484	8.1	1.2	1122

TABLE 3.1. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
50-Meter Dash (sec.)	10	10.1	1.0	69	9.4	0.9	75	9.7	1.0	144
	11	9.8	1.2	58	9.0	0.9	69	9.4	1.1	127
	12	9.0	0.8	104	9.0	0.9	90	9.0	0.8	194
	13	9.0	0.9	130	8.6	0.8	50	8.8	0.9	180
	14	9.1	1.9	123	7.6	1.0	33	8.8	1.8	156
	15	9.0	1.6	61	7.5	0.6	60	8.2	1.4	121
	16	9.1	1.5	62	7.5	0.7	74	8.2	1.4	136
	17	9.7	1.4	28	7.9	1.3	33	8.7	1.6	61
	Entire	9.2	1.4	635	8.4	1.2	484	8.9	1.3	1119
Rise-to-Stand (sec.)	10	1.7	0.5	61	1.6	0.4	61	1.7	0.4	122
	11	1.7	0.4	49	1.5	0.4	49	1.6	0.4	98
	12	1.7	0.4	109	1.6	0.4	88	1.6	0.4	197
	13	1.6	0.5	129	1.5	0.5	50	1.6	0.5	179
	14	1.7	0.5	133	1.3	0.3	37	1.6	0.5	170
	15	1.5	0.4	64	1.3	0.3	59	1.4	0.4	123
	16	1.6	0.5	71	1.3	0.5	75	1.5	0.5	146
	17	1.5	0.4	29	1.5	0.5	35	1.5	0.4	64
	Entire	1.6	0.5	645	1.5	0.4	454	1.6	0.5	1099
Mat Creep (sec.)	10	4.1	0.6	66	3.7	0.7	77	3.9	0.7	143
	11	4.0	0.8	57	3.6	0.5	65	3.8	0.7	122
	12	4.2	0.7	108	3.8	0.5	85	4.0	0.7	193
	13	4.2	0.8	128	3.5	0.5	53	4.0	0.8	181
	14	4.3	1.0	130	3.2	0.4	37	4.0	1.0	167
	15	4.0	0.8	64	3.3	0.6	58	3.6	0.8	122
	16	4.1	0.9	70	3.3	0.6	70	3.7	0.9	140
	17	4.4	1.3	28	3.7	0.9	35	4.0	1.1	63
	Entire	4.2	0.9	651	3.5	0.6	480	3.9	0.8	1131
Shuttle Run (sec.)	10	11.7	0.8	62	11.3	1.0	67	11.5	0.9	129
	11	11.6	1.0	42	11.1	0.9	60	11.3	1.0	102
	12	11.5	1.0	99	11.2	1.1	78	11.3	1.0	177
	13	11.6	0.9	128	11.1	0.8	51	11.5	0.9	179
	14	11.5	1.2	128	10.2	0.8	36	11.2	1.2	164
	15	11.1	1.1	63	10.0	1.1	57	10.5	1.2	120
	16	11.4	1.4	64	9.8	0.9	68	10.6	1.4	132
	17	11.6	1.3	28	10.3	1.4	34	10.9	1.5	62
	Entire	11.5	1.1	614	10.7	1.2	451	11.1	1.2	1065

TABLE 3.1. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit and Reach (cm.)	10	28.4	6.3	70	24.0	6.3	77	26.1	6.6	147
	11	28.0	7.0	60	22.4	7.0	68	25.0	7.5	128
	12	28.9	8.5	113	23.3	6.4	91	26.4	8.1	204
	13	32.4	7.3	130	22.7	6.3	53	29.6	8.3	183
	14	32.2	8.4	134	27.5	8.5	37	31.2	8.6	171
	15	32.4	8.5	63	26.9	9.3	59	29.7	9.3	122
	16	34.0	7.8	70	28.3	8.9	71	31.1	8.8	141
	17	33.5	6.6	28	27.8	7.7	35	30.3	7.8	63
	Entire	31.2	8.0	668	25.0	7.8	491	28.6	8.5	1159
Long Distance Run (Yards per Minute)	10	251.8	184.3	71	269.3	173.8	77	260.9	178.6	148
	11	354.9	219.6	62	355.5	193.9	69	355.2	205.6	131
	12	391.2	218.1	115	357.4	205.2	93	376.1	212.6	208
	13	246.0	179.6	131	353.8	203.8	53	277.1	192.6	184
	14	273.7	195.9	135	520.8	156.9	38	327.9	213.8	173
	15	195.3	125.8	64	256.1	121.5	61	225.0	127.0	125
	16	213.2	136.1	72	305.5	159.4	80	261.8	155.3	152
	17	288.8	189.2	31	316.8	160.7	40	304.6	173.0	71
	Entire	280.2	196.4	681	332.2	187.3	511	302.5	194.2	1192
Stork Stand (sec.)	10	20.5	29.6	68	15.2	12.2	75	17.7	22.3	143
	11	39.7	95.8	60	26.4	28.0	65	32.7	69.4	125
	12	43.3	51.8	111	29.2	39.9	87	37.1	47.3	198
	13	57.5	74.0	131	46.8	44.6	51	54.5	67.1	182
	14	35.3	31.9	131	41.8	52.1	37	36.7	37.2	168
	15	36.3	46.9	62	39.0	77.8	58	37.6	63.5	120
	16	32.5	35.3	70	34.6	29.2	69	33.5	32.3	139
	17	26.7	24.9	28	44.5	38.6	36	36.7	34.3	64
	Entire	39.3	55.8	661	32.6	43.4	478	36.5	51.0	1139

TABLE 3.2. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON SUBJECTS WITH AUDITORY IMPAIRMENTS.

		Female			Male			Combined		
Variable	Age	Mean	SD	N	Mean	SD	N	Mean	SD	N
Tricep Skinfold (mm.)	10	13.5	5.0	37	12.7	6.6	72	13.0	6.1	109
	11	13.2	4.6	53	12.8	6.0	66	12.9	5.4	119
	12	17.0	7.0	52	13.0	6.2	64	14.8	6.9	116
	13	16.2	6.6	64	12.8	5.7	96	14.1	6.2	160
	14	17.2	6.6	71	11.1	6.1	84	13.9	7.0	155
	15	17.8	8.0	116	10.9	5.3	139	14.1	7.5	255
	16	17.6	6.9	129	11.7	6.1	179	14.2	7.1	308
	17	16.9	6.0	64	11.4	5.8	86	13.7	6.5	150
	Entire	16.7	6.8	586	11.9	6.0	786	13.9	6.8	1372
Abdominal Skinfold (mm.)	10	10.5	4.4	37	11.5	8.7	72	11.2	7.5	109
	11	12.3	5.7	53	13.4	9.9	66	12.9	8.3	119
	12	15.8	6.8	52	14.3	11.0	64	15.0	9.4	116
	13	16.6	8.0	64	13.0	7.5	96	14.4	7.9	160
	14	17.0	7.6	71	13.7	9.2	84	15.2	8.6	155
	15	17.6	8.4	116	13.7	8.4	139	15.5	8.6	255
	16	18.2	7.1	129	14.5	8.4	179	16.1	8.1	308
	17	18.1	8.6	64	13.5	7.6	86	15.5	8.3	150
	Entire	16.5	7.7	586	13.6	8.7	786	14.8	8.4	1372
Subscapular Skinfold (mm.)	10	9.6	4.0	37	8.8	5.4	72	9.1	5.0	109
	11	10.0	3.9	53	10.1	7.1	66	10.1	5.9	119
	12	13.6	6.5	52	10.9	7.4	64	12.1	7.1	116
	13	13.5	4.7	64	10.8	6.3	96	11.9	5.9	160
	14	14.7	6.4	71	10.4	5.4	84	12.3	6.2	155
	15	14.8	6.8	116	10.8	4.9	139	12.6	6.2	255
	16	15.6	5.6	129	11.4	5.4	179	13.1	5.8	308
	17	15.4	6.9	64	11.3	4.7	86	13.1	6.1	150
	Entire	14.0	6.2	586	10.7	5.7	786	12.1	6.1	1372
Sum of Triceps and Subscapular Skinfolds (mm.)	10	23.2	8.3	37	21.5	11.4	72	22.1	10.5	109
	11	23.2	7.7	53	22.9	12.3	66	23.0	10.4	119
	12	30.6	12.7	52	23.8	13.0	64	26.9	13.2	116
	13	29.7	10.2	64	23.6	10.9	96	26.0	11.0	160
	14	31.9	12.2	71	21.5	10.5	84	26.3	12.4	155
	15	32.7	13.6	116	21.7	9.6	139	26.7	12.8	255
	16	33.2	11.5	129	23.1	10.4	179	27.3	12.0	308
	17	32.3	10.8	64	22.7	9.7	86	26.8	11.2	150
	Entire	30.7	11.9	586	22.6	10.8	786	26.0	12.0	1372

TABLE 3.2. (cont.)

Variable	Age	Female			Male			Combined		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
Sit-Ups (no.)	10	24.3	9.3	39	29.4	9.6	71	27.6	9.7	110
	11	29.3	10.0	59	30.0	12.0	67	29.7	11.1	126
	12	28.5	9.7	56	31.8	10.5	65	30.2	10.2	121
	13	27.8	9.4	72	33.3	11.7	98	31.0	11.1	170
	14	28.6	11.2	70	34.9	12.1	84	32.0	12.1	154
	15	29.6	10.8	122	36.7	11.2	140	33.4	11.5	262
	16	31.2	11.3	140	38.4	11.6	196	35.4	12.0	336
	17	32.7	11.2	64	40.0	10.2	92	37.0	11.2	156
	Entire	29.5	10.7	622	35.3	11.7	813	32.8	11.6	1435
Leg Raise (sec.)	10	23.7	16.2	39	28.2	25.1	71	26.6	22.4	110
	11	21.8	19.4	59	26.6	28.7	67	24.4	24.8	126
	12	21.1	15.3	56	28.1	21.2	64	24.8	19.0	120
	13	18.9	15.0	78	28.7	24.0	96	24.3	21.0	174
	14	24.5	19.0	73	36.7	26.8	82	30.9	24.2	155
	15	33.2	22.2	122	41.3	24.6	136	37.5	23.8	258
	16	35.3	23.6	141	49.6	34.2	194	43.6	31.0	335
	17	37.1	27.0	66	57.9	34.9	91	49.2	33.4	157
	Entire	28.6	21.8	634	39.8	30.6	801	34.8	27.6	1435
Trunk Raise (sec.)	10	36.6	23.7	38	34.2	33.0	70	35.1	30.0	108
	11	44.3	28.9	57	42.9	35.0	67	43.5	32.2	124
	12	36.1	25.1	53	42.3	27.8	64	39.5	26.7	117
	13	35.1	27.0	75	40.6	29.7	96	38.1	28.6	171
	14	36.4	27.7	68	40.3	29.6	80	38.5	28.7	148
	15	40.8	35.9	120	41.0	35.0	132	40.9	35.3	252
	16	45.6	40.0	139	50.7	41.8	188	48.5	41.1	327
	17	51.5	39.2	65	46.2	37.5	91	48.4	38.1	156
	Entire	41.5	33.6	615	43.4	35.5	788	42.6	34.7	1403
Right Grip (kg.)	10	14.9	8.5	40	15.3	6.3	71	15.1	7.2	111
	11	14.7	7.4	57	14.9	6.3	69	14.8	6.8	126
	12	19.2	7.1	54	21.1	8.3	65	20.2	7.8	119
	13	21.3	7.4	71	24.4	9.1	96	23.1	8.5	167
	14	24.1	8.2	70	29.9	10.6	83	27.2	10.0	153
	15	24.6	8.4	122	35.7	10.6	141	30.5	11.1	263
	16	24.3	7.5	139	39.4	10.3	196	33.1	11.8	335
	17	27.0	7.8	65	46.1	10.7	92	38.2	13.4	157
	Entire	22.3	8.7	618	31.1	13.9	813	27.3	12.7	1431

TABLE 3.2. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Left Grip (kg.)	10	13.4	7.9	40	14.1	6.6	71	13.8	7.1	111
	11	13.5	7.3	57	13.7	6.0	69	13.6	6.6	126
	12	17.6	7.0	54	19.0	8.2	65	18.3	7.7	119
	13	20.0	7.5	71	22.2	9.7	97	21.3	8.9	168
	14	21.4	7.7	70	28.4	11.1	83	25.2	10.3	153
	15	22.4	8.1	122	33.3	9.9	141	28.2	10.6	263
	16	21.6	6.7	139	36.5	9.4	197	30.3	11.1	336
	17	24.3	7.4	65	42.5	10.3	91	34.9	12.9	156
	Entire	20.2	8.1	618	28.8	13.2	814	25.1	12.1	1432
Sum of Grips (kg.)	10	28.2	16.4	40	29.4	12.7	71	14.1	14.1	111
	11	28.2	14.5	57	28.7	12.0	69	13.1	13.1	126
	12	36.7	13.8	54	40.1	16.2	65	15.2	15.2	119
	13	41.3	14.5	71	46.4	18.3	96	16.9	16.9	167
	14	45.5	15.5	70	58.3	20.2	83	19.2	19.2	153
	15	47.0	16.1	122	69.0	19.9	141	21.3	21.3	263
	16	45.9	13.9	139	75.9	19.0	196	22.6	22.6	335
	17	51.3	14.7	65	88.6	20.1	91	25.8	25.8	156
	Entire	42.5	16.5	618	59.9	26.7	812	24.4	24.4	1430
Arm Hang (sec.)	10	6.7	7.1	38	8.9	9.9	68	8.1	9.1	106
	11	7.9	7.6	57	9.5	12.1	64	8.8	10.2	121
	12	4.7	5.2	55	9.5	10.2	60	7.2	8.5	115
	13	4.2	6.9	77	14.2	16.0	90	9.6	13.6	167
	14	6.6	8.7	68	17.1	15.0	69	11.8	13.3	137
	15	6.4	7.9	112	21.3	15.7	123	14.2	14.6	235
	16	9.7	10.9	135	23.9	15.0	170	17.6	15.1	305
	17	6.8	8.5	67	22.2	14.9	78	15.1	14.5	145
	Entire	6.9	8.6	609	17.5	15.3	722	12.7	13.8	1331
Pull-Ups (no.)	10	0.9	1.7	40	1.7	2.2	70	1.4	2.1	110
	11	0.8	1.3	58	1.5	2.1	65	1.2	1.8	123
	12	0.3	0.8	54	2.2	2.5	65	1.3	2.1	119
	13	0.4	1.1	69	3.2	3.3	97	2.0	3.0	166
	14	0.9	2.1	63	4.1	4.3	82	2.7	3.8	145
	15	0.9	2.3	116	5.4	4.0	138	3.4	4.0	254
	16	0.7	1.3	139	6.1	4.5	196	3.9	4.4	335
	17	0.5	1.1	57	6.8	4.6	92	4.4	4.8	149
	Entire	0.7	1.6	596	4.4	4.2	805	2.8	3.8	1401

TABLE 3.2. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Broad Jump (inches)	10	48.9	10.9	38	52.3	8.6	67	51.0	9.6	105
	11	53.6	8.7	56	54.8	9.4	62	54.2	9.1	118
	12	56.0	9.9	52	60.9	9.6	59	58.6	10.0	111
	13	58.2	8.1	71	65.5	12.5	98	62.4	11.4	169
	14	57.2	10.3	63	69.4	13.1	83	64.1	13.4	146
	15	60.2	10.9	116	74.8	12.5	132	68.0	13.8	248
	16	58.9	12.4	132	77.9	11.6	186	70.0	15.2	318
	17	59.9	11.5	65	82.9	11.9	85	72.9	16.3	150
	Entire	57.6	11.1	593	70.0	15.0	772	64.6	14.8	1365
Softball Distance (inches)	10	491.9	136.2	38	824.0	307.8	64	700.3	303.2	102
	11	566.1	169.7	54	806.8	254.9	57	689.7	248.1	111
	12	667.1	214.0	48	1159.3	359.3	60	940.6	389.4	108
	13	766.8	243.7	67	1282.8	348.0	83	1052.3	399.0	150
	14	889.7	310.8	70	1402.7	435.9	77	1158.4	459.0	147
	15	914.0	379.7	120	1531.5	468.2	134	1239.8	527.7	254
	16	887.2	348.0	142	1597.8	444.9	195	1298.3	537.2	337
	17	887.7	346.7	65	1759.2	524.4	89	1391.4	628.4	154
	Entire	808.4	335.9	604	1391.5	514.5	759	1133.1	530.3	1363
Softball Velocity (feet per second)	10	35.7	5.8	20	46.7	7.8	32	42.5	8.9	52
	11	39.6	6.0	35	46.2	7.2	33	42.8	7.3	68
	12	43.1	8.3	28	55.9	8.8	30	49.7	10.6	58
	13	46.8	8.4	44	60.5	7.5	52	54.2	10.5	96
	14	49.4	7.6	56	62.4	13.8	62	56.2	13.0	118
	15	49.3	8.7	78	64.1	10.3	105	57.8	12.1	183
	16	47.2	8.4	114	63.7	9.5	138	56.2	12.2	252
	17	49.3	9.3	47	69.2	10.0	70	61.2	13.8	117
	Entire	46.6	8.9	422	61.4	11.7	522	54.8	12.9	944
50-Yard Dash (sec.)	10	9.4	1.1	34	8.9	0.8	65	9.1	1.0	99
	11	9.0	1.2	51	9.1	1.8	61	9.1	1.5	112
	12	8.7	1.0	46	8.7	1.6	61	8.7	1.4	107
	13	8.7	1.3	60	8.5	2.0	83	8.6	1.8	143
	14	8.4	1.4	66	7.8	1.4	74	8.1	1.4	140
	15	8.7	2.3	119	7.3	1.1	132	8.0	1.9	251
	16	8.3	1.3	141	7.1	0.8	197	7.6	1.2	338
	17	8.1	0.9	65	6.9	0.7	91	7.4	1.0	156
	Entire	8.6	1.5	582	7.8	1.5	764	8.1	1.6	1346

TABLE 3.2. (cont.)

Variable	Age	Female			Male			Combined		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
50-Meter Dash (sec.)	10	10.6	1.4	34	10.1	1.6	69	10.3	1.5	103
	11	9.9	1.1	53	10.0	1.8	62	10.0	1.5	115
	12	9.6	1.1	46	9.5	1.6	61	9.5	1.4	107
	13	9.6	1.5	60	9.2	2.0	83	9.4	1.8	143
	14	9.4	1.5	66	8.6	1.5	74	9.0	1.5	140
	15	9.5	2.3	116	8.0	1.2	129	8.7	2.0	245
	16	9.3	1.6	131	7.6	0.9	172	8.4	1.5	303
	17	8.8	1.0	65	7.4	0.8	87	8.0	1.1	152
	Entire	9.5	1.6	571	8.5	1.7	737	9.0	1.7	1308
Rise-to-Stand (sec.)	10	1.6	0.4	37	1.7	0.6	63	1.7	0.5	100
	11	1.8	0.5	55	1.7	0.6	66	1.8	0.6	121
	12	1.7	0.4	56	1.6	0.8	64	1.7	0.6	120
	13	1.7	0.4	71	1.6	0.6	98	1.6	0.5	169
	14	1.7	0.6	72	1.5	0.6	82	1.6	0.6	154
	15	1.7	0.6	123	1.4	0.5	139	1.5	0.6	262
	16	1.6	0.6	139	1.4	0.5	198	1.5	0.5	337
	17	1.7	0.6	63	1.3	0.5	92	1.4	0.6	155
	Entire	1.7	0.5	616	1.5	0.6	802	1.6	0.6	1418
Mat Creep (sec.)	10	4.6	1.0	36	4.2	1.0	61	4.3	1.0	97
	11	4.6	1.2	53	4.5	1.6	64	4.5	1.4	117
	12	4.5	1.2	55	4.1	1.4	64	4.3	1.3	119
	13	4.3	1.3	77	4.2	1.7	96	4.3	1.5	173
	14	4.5	1.1	71	3.9	1.0	84	4.2	1.1	155
	15	4.4	1.3	119	3.6	0.9	135	4.0	1.2	254
	16	4.4	1.1	140	3.6	0.9	193	3.9	1.1	333
	17	4.2	1.2	63	3.4	0.8	90	3.8	1.1	153
	Entire	4.4	1.2	614	3.8	1.2	787	4.1	1.2	1401
Shuttle Run (sec.)	10	13.2	2.6	38	12.1	1.8	67	12.5	2.2	105
	11	12.3	2.0	56	12.7	3.1	65	12.5	2.6	121
	12	12.0	1.3	56	11.9	2.4	64	11.9	1.9	120
	13	12.2	2.3	71	11.7	3.1	97	11.9	2.8	168
	14	12.0	1.6	61	11.2	1.9	83	11.5	1.8	144
	15	12.1	2.4	114	10.5	1.2	133	11.2	2.0	247
	16	11.8	2.1	131	10.3	1.2	186	10.9	1.8	317
	17	11.6	1.8	62	10.0	1.3	85	10.6	1.7	147
	Entire	12.0	2.1	589	11.0	2.1	780	11.5	2.2	1369

TABLE 3.2. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit and Reach (cm.)	10	24.0	6.5	40	22.7	6.5	69	23.2	6.5	109
	11	23.5	6.8	59	21.3	7.2	69	22.3	7.1	128
	12	26.1	7.9	56	24.0	7.2	64	25.0	7.6	120
	13	26.0	7.6	72	22.6	8.3	96	24.0	8.2	168
	14	27.3	8.4	71	24.1	10.0	83	25.6	9.4	154
	15	29.1	8.9	123	25.0	8.7	139	26.9	9.0	262
	16	28.4	8.8	140	26.3	9.4	196	27.2	9.2	336
	17	29.4	9.5	64	29.3	8.3	92	29.3	8.8	156
	Entire	27.3	8.5	625	24.8	8.8	808	25.9	8.8	1433
Long Distance Run (Yards per minute)	10	145.7	34.6	34	172.9	38.8	61	163.2	39.4	95
	11	164.2	35.8	47	170.9	45.7	55	167.8	41.4	102
	12	158.0	31.2	36	180.3	43.4	41	169.9	39.6	77
	13	151.2	36.7	59	191.2	42.3	77	173.8	44.6	136
	14	158.1	38.7	64	194.4	52.5	69	176.9	49.7	133
	15	151.2	43.8	113	202.6	47.8	120	177.7	52.5	233
	16	164.0	40.8	109	207.9	48.3	152	189.6	50.2	261
	17	154.7	34.5	55	221.1	44.2	72	192.3	52.0	127
	Entire	156.4	38.9	517	196.8	48.5	647	178.8	48.8	1164
Stork Stand (sec.)	10	9.6	13.2	40	11.7	20.4	72	10.9	18.1	112
	11	6.5	8.2	57	9.1	12.0	69	7.9	10.5	126
	12	7.3	7.5	55	6.8	9.4	65	7.0	8.5	120
	13	5.3	6.1	78	12.2	19.6	98	9.1	15.5	176
	14	10.0	17.0	74	14.4	24.1	82	12.3	21.1	156
	15	13.5	20.2	122	12.8	17.9	138	13.2	19.0	260
	16	12.7	14.6	140	13.4	18.2	191	13.1	16.8	331
	17	12.9	17.3	67	9.5	12.0	89	11.0	14.5	156
	Entire	10.4	15.0	633	11.8	17.7	804	11.2	16.6	1437

TABLE 3.3. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON SUBJECTS WITH VISUAL IMPAIRMENTS.

Variable	Age	Female			Male			Combined		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
Tricep Skinfold (mm.)	10	12.3	6.4	14	12.7	6.2	39	12.6	6.2	53
	11	15.4	7.6	27	13.9	5.1	33	14.6	6.3	60
	12	16.5	7.2	30	15.6	9.0	41	16.0	8.3	71
	13	15.8	7.6	39	13.8	7.4	43	14.8	7.5	82
	14	15.9	8.8	38	11.7	7.3	69	13.2	8.1	107
	15	16.5	7.5	42	12.1	6.4	56	14.0	7.2	98
	16	18.2	9.3	35	11.7	7.3	55	14.2	8.7	90
	17	17.7	9.0	35	12.4	6.2	46	14.7	8.0	81
	Entire	16.4	8.1	260	12.8	7.1	382	14.2	7.7	642
Abdominal Skinfold (mm.)	10	10.4	6.2	14	10.1	8.5	39	10.2	7.9	53
	11	14.6	9.4	27	13.7	8.0	33	14.1	8.6	60
	12	15.9	10.1	30	16.2	13.7	41	16.0	12.3	71
	13	14.3	8.1	39	15.8	12.0	43	15.1	10.3	82
	14	16.6	11.4	37	14.3	11.2	69	15.1	11.3	106
	15	16.3	8.2	42	15.5	10.1	56	15.8	9.3	98
	16	18.3	12.1	35	14.7	11.3	55	16.1	11.7	90
	17	16.3	8.7	35	17.9	10.1	46	17.3	9.5	81
	Entire	15.8	9.7	259	14.9	10.9	382	15.2	10.4	641
Subscapular Skinfold (mm.)	10	7.5	3.6	14	8.8	6.5	39	8.5	5.9	53
	11	13.5	8.3	27	10.5	5.2	33	11.8	6.9	60
	12	12.6	5.3	30	12.7	10.2	41	12.6	8.4	71
	13	12.7	5.1	38	12.8	9.4	43	12.8	7.7	81
	14	14.9	10.1	38	11.1	7.5	68	12.4	8.7	106
	15	15.4	8.6	42	12.5	6.9	56	13.7	7.8	98
	16	15.6	7.7	35	13.3	10.1	54	14.2	9.3	89
	17	14.9	7.6	35	13.8	5.9	46	14.3	6.7	81
	Entire	13.9	7.7	259	12.0	8.1	380	12.8	8.0	639
Sum of Triceps and Subscapular Skinfolds (mm.)	10	19.8	9.2	14	21.5	12.2	39	21.0	11.4	53
	11	28.9	15.3	27	24.5	9.0	33	26.4	12.3	60
	12	29.1	12.1	30	28.2	18.5	41	28.6	16.0	71
	13	28.7	12.1	38	26.6	16.2	43	27.6	14.4	81
	14	30.8	18.4	38	22.7	14.3	68	25.6	16.3	106
	15	31.8	15.4	42	24.5	12.4	56	27.7	14.2	98
	16	33.8	15.6	35	25.2	16.3	54	28.5	16.5	89
	17	32.7	15.7	35	26.2	11.0	46	29.0	13.6	81
	Entire	30.3	15.0	259	24.8	14.2	380	27.0	14.8	639

TABLE 3.3. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit-Ups (no.)	10	27.1	10.4	14	30.6	11.1	39	29.7	10.9	53
	11	25.9	9.2	27	31.6	13.1	33	29.0	11.8	60
	12	28.1	9.6	31	32.6	10.6	39	30.6	10.3	70
	13	28.1	9.6	39	37.3	12.7	42	32.9	12.1	81
	14	28.6	9.3	37	35.4	9.8	66	33.0	10.1	103
	15	30.5	10.4	43	35.3	12.4	55	33.2	11.7	98
	16	31.5	7.3	35	36.9	11.0	57	34.8	10.1	92
	17	29.1	10.4	35	39.4	10.4	46	34.9	11.6	81
	Entire	28.9	9.5	261	35.2	11.5	377	32.6	11.2	638
Leg Raise (sec.)	10	15.1	14.2	14	28.1	31.4	39	24.6	28.4	53
	11	27.0	24.6	27	27.4	24.0	32	27.2	24.1	59
	12	23.2	33.0	31	23.9	19.9	39	23.6	26.3	70
	13	22.9	27.8	37	23.1	20.9	42	23.1	24.2	79
	14	21.9	19.1	37	30.5	26.2	67	27.5	24.2	104
	15	32.2	31.1	43	40.0	40.8	54	36.6	36.9	97
	16	28.7	29.4	35	49.6	46.6	57	41.7	42.0	92
	17	31.2	32.4	35	57.1	40.3	47	46.1	39.1	82
	Entire	26.3	28.1	259	36.1	35.3	377	32.1	32.9	636
Trunk Raise (sec.)	10	18.4	19.3	12	16.5	15.6	38	16.9	16.3	50
	11	15.2	17.1	26	34.6	36.5	32	25.9	30.8	58
	12	26.5	28.1	30	33.5	38.3	39	30.5	34.2	69
	13	35.3	38.6	36	30.3	24.2	42	32.6	31.6	78
	14	31.4	28.0	36	37.0	31.0	67	35.1	30.0	103
	15	39.4	34.6	42	35.5	34.0	52	37.2	34.1	94
	16	39.9	38.6	35	40.4	35.0	56	40.2	36.2	91
	17	32.7	30.1	35	35.5	26.3	47	34.3	27.9	82
	Entire	31.8	32.2	252	33.7	31.4	373	32.9	31.7	625
Right Grip (kg.)	10	10.5	4.0	14	11.7	6.4	38	11.4	5.8	52
	11	13.1	6.4	27	15.2	8.1	33	14.2	7.4	60
	12	16.6	6.5	31	19.6	7.5	41	18.3	7.2	72
	13	15.9	5.6	39	21.3	10.8	43	18.7	9.1	82
	14	16.7	7.1	38	25.1	9.9	68	22.1	9.8	106
	15	17.9	9.1	43	29.8	9.6	57	24.7	11.1	100
	16	21.0	8.1	35	33.8	10.1	56	28.9	11.3	91
	17	22.7	7.0	35	36.1	11.9	47	30.4	12.1	82
	Entire	17.4	7.8	262	25.2	12.3	383	22.1	11.3	645

TABLE 3.3. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Left Grip (kg.)	10	9.4	3.7	14	10.2	6.4	38	10.0	5.7	52
	11	11.9	6.5	27	13.8	8.[illegible]	33	13.0	7.4	60
	12	15.3	6.0	31	16.8	6.3	[illegible]1	16.2	6.2	72
	13	14.3	5.7	39	18.4	8.8	4[illegible]	16.5	7.7	82
	14	15.1	5.9	38	22.6	10.1	67	19.9	9.5	105
	15	16.4	8.7	43	26.6	8.7	57	22.2	10.0	100
	16	19.8	7.8	35	31.1	9.3	56	26.8	10.3	91
	17	19.8	6.9	35	32.8	12.2	47	27.3	12.1	82
	Entire	15.8	7.3	262	22.6	11.6	382	19.9	10.6	644
Sum of Grips (kg.)	10	19.9	7.4	14	22.0	12.5	38	21.4	11.3	52
	11	25.0	12.8	27	29.0	15.9	33	27.2	14.6	60
	12	31.9	12.1	31	36.5	13.5	41	34.5	13.0	72
	13	30.2	11.0	39	39.7	19.3	43	35.2	16.5	82
	14	31.8	12.8	38	47.4	19.2	67	41.8	18.7	105
	15	34.3	17.3	43	56.4	17.4	57	46.9	20.5	100
	16	40.8	15.0	35	64.9	18.5	56	55.6	20.8	91
	17	42.5	13.1	35	68.9	23.5	47	57.6	23.6	82
	Entire	33.3	14.6	262	47.8	23.4	382	41.9	21.5	644
Arm Hang (sec.)	10	4.9	6.1	13	8.1	8.5	37	7.2	8.0	50
	11	4.8	6.3	27	11.6	11.9	30	8.4	10.2	57
	12	6.3	6.2	30	8.5	8.5	35	7.5	7.5	65
	13	3.8	4.2	32	11.4	13.2	41	8.0	10.9	73
	14	6.2	7.5	33	14.6	16.0	61	11.6	14.2	94
	15	5.3	5.0	41	15.5	14.6	48	10.8	12.3	89
	16	5.8	6.3	33	15.0	13.5	43	11.1	11.8	76
	17	10.9	13.9	29	20.0	17.7	42	16.2	16.8	71
	Entire	6.0	7.6	238	13.4	14.1	337	10.4	12.4	575
Pull-Ups (no.)	10	0.7	1.5	14	1.9	2.1	38	1.6	2.0	52
	11	0.6	1.4	27	2.0	2.6	33	1.4	2.2	60
	12	1.1	2.1	31	1.6	2.0	40	1.4	2.0	71
	13	1.0	2.2	34	3.1	3.9	43	2.2	3.4	77
	14	0.8	1.7	36	3.6	3.8	69	2.6	3.5	105
	15	0.7	1.6	43	3.9	4.1	55	2.5	3.6	98
	16	0.9	1.9	35	4.6	4.2	54	3.2	4.0	89
	17	0.5	1.2	30	5.7	4.7	47	3.7	4.5	77
	Entire	0.8	1.7	250	3.5	3.9	379	2.4	3.5	629

TABLE 3.3. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Broad Jump (inches)	10	40.2	10.7	13	49.5	10.3	39	47.2	11.1	52
	11	44.0	14.8	27	52.5	10.7	33	48.7	13.3	60
	12	50.9	14.9	30	56.8	11.4	38	54.2	13.3	68
	13	48.2	11.4	36	59.3	16.3	42	54.2	15.2	78
	14	53.2	14.5	37	64.2	17.0	66	60.2	16.9	103
	15	54.4	11.5	42	67.6	17.6	56	61.9	16.6	98
	16	55.3	12.1	34	70.3	17.2	58	64.8	17.1	92
	17	53.9	12.2	35	73.1	17.3	47	64.9	18.0	82
	Entire	51.1	13.4	254	62.9	17.2	379	58.2	16.8	633
Softball Distance (inches)	10	271.4	146.4	13	520.6	251.5	36	454.5	252.6	49
	11	360.6	243.3	25	648.4	276.3	29	515.2	296.9	54
	12	568.9	302.0	29	785.1	354.9	33	684.0	346.1	62
	13	464.8	249.9	31	835.4	431.4	39	671.3	405.0	70
	14	529.1	233.1	28	974.5	421.2	55	824.2	423.8	83
	15	552.0	277.6	33	1088.2	568.8	44	858.4	535.6	77
	16	678.5	302.0	30	1091.8	492.0	43	921.9	468.9	73
	17	549.3	265.6	28	1239.1	524.0	41	959.2	553.2	69
	Entire	517.1	280.6	217	922.7	487.2	320	758.8	461.1	537
Softball Velocity (feet per second)	10	26.4	6.7	10	35.1	9.4	25	32.6	9.5	35
	11	31.1	10.0	17	39.7	9.5	20	35.7	10.5	37
	12	39.2	11.5	19	47.3	12.4	24	43.7	12.6	43
	13	33.2	10.6	14	47.4	12.1	19	41.4	13.4	33
	14	38.5	7.5	13	50.4	8.9	26	46.4	10.1	39
	15	35.6	9.3	13	62.3	26.4	16	50.3	24.3	29
	16	44.2	11.7	15	50.5	11.7	22	48.0	12.0	37
	17	40.1	8.2	16	54.5	16.4	21	48.2	15.1	37
	Entire	36.5	10.8	117	47.8	15.4	173	43.2	14.8	290
50-Yard Dash (sec.)	10	11.6	2.1	13	10.3	3.2	36	10.7	3.0	49
	11	10.5	1.9	25	10.4	2.4	30	10.4	2.2	55
	12	9.8	2.3	30	9.6	3.9	37	9.7	3.2	67
	13	10.3	2.3	32	9.4	2.6	39	9.8	2.5	71
	14	9.6	2.1	33	8.7	2.1	60	9.1	2.1	93
	15	9.0	1.7	37	8.3	1.9	50	8.6	1.9	87
	16	9.0	1.9	33	8.2	1.8	55	8.5	1.9	88
	17	10.0	2.1	35	8.0	3.1	46	8.8	2.9	81
	Entire	9.8	2.1	238	8.9	2.7	353	9.3	2.5	591

TABLE 3.3. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
50-Meter Dash (sec.)	10	13.2	2.3	12	11.4	3.6	36	11.9	3.4	48
	11	11.6	2.1	26	11.4	2.7	33	11.5	2.5	59
	12	11.0	2.3	30	10.6	4.2	39	10.8	3.5	69
	13	11.3	2.5	35	10.2	2.8	42	10.7	2.7	77
	14	10.7	2.3	35	9.6	2.2	62	10.0	2.3	97
	15	10.0	1.8	41	9.2	2.0	53	9.5	1.9	94
	16	9.9	2.1	33	9.0	2.2	56	9.3	2.2	89
	17	11.0	2.3	35	8.7	3.5	47	9.7	3.2	82
	Entire	10.8	2.3	247	9.9	3.0	368	10.2	2.8	615
Rise-to-Stand (sec.)	10	1.8	0.7	14	1.8	0.5	39	1.8	0.6	53
	11	2.2	1.0	27	2.0	0.8	33	2.1	0.9	60
	12	2.1	0.6	31	1.7	0.5	39	1.9	0.6	70
	13	1.9	0.7	37	1.8	0.7	42	1.8	0.7	79
	14	1.9	0.6	36	1.8	0.9	67	1.8	0.8	103
	15	2.0	0.6	41	1.8	0.7	54	1.9	0.7	95
	16	2.0	0.6	35	1.6	0.6	55	1.7	0.6	90
	17	2.1	0.8	35	1.5	0.5	47	1.7	0.7	82
	Entire	2.0	0.7	256	1.7	0.7	376	1.8	0.7	632
Mat Creep (sec.)	10	5.5	1.4	13	4.7	1.1	37	4.9	1.2	50
	11	5.2	1.3	27	4.7	1.8	32	4.9	1.6	59
	12	6.7	6.7	30	4.6	1.2	37	5.5	4.7	67
	13	5.2	1.5	35	4.3	1.6	40	4.7	1.6	75
	14	5.1	1.5	33	4.2	1.3	61	4.5	1.5	94
	15	5.7	2.9	40	4.4	1.2	45	5.0	2.3	85
	16	5.7	2.6	33	4.7	1.7	47	5.1	2.2	80
	17	5.2	1.3	30	4.3	1.8	42	4.7	1.6	72
	Entire	5.5	3.0	241	4.5	1.5	341	4.9	2.3	582
Shuttle Run (sec.)	10	14.6	2.7	13	16.5	9.2	36	16.0	8.1	49
	11	17.6	10.5	26	13.2	2.3	32	15.1	7.5	58
	12	15.1	5.2	30	14.4	10.9	36	14.7	8.7	66
	13	16.2	9.2	32	13.3	3.9	39	14.6	6.9	71
	14	13.7	2.8	33	12.7	3.4	59	13.1	3.2	92
	15	14.0	2.7	37	12.4	2.4	49	13.1	2.6	86
	16	13.4	2.1	33	12.2	2.7	48	12.7	2.5	81
	17	14.0	2.7	28	12.0	2.8	41	12.8	2.9	69
	Entire	14.8	5.7	232	13.2	5.5	340	13.8	5.6	572

TABLE 3.3. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit and Reach (cm.)	10	23.9	6.3	14	24.6	8.2	39	24.4	7.7	53
	11	26.8	7.1	27	23.1	8.1	31	24.8	7.8	58
	12	26.6	8.9	31	23.3	8.7	39	24.8	8.8	70
	13	26.0	9.2	34	23.2	9.0	41	24.5	9.2	75
	14	26.4	8.1	36	25.2	9.0	63	25.6	8.7	99
	15	28.4	9.4	41	22.7	10.5	50	25.3	10.3	91
	16	29.0	9.4	33	26.6	9.6	52	27.6	9.6	85
	17	26.5	10.2	31	26.2	8.7	43	26.4	9.3	74
	Entire	27.0	8.8	247	24.5	9.1	358	25.5	9.1	605
Long Distance Run (Yards per Minute)	10	141.6	42.2	13	153.1	33.5	35	150.0	36.0	48
	11	147.8	28.5	22	163.0	46.2	29	156.4	40.0	51
	12	152.4	48.9	26	157.9	33.1	31	155.4	40.7	57
	13	139.8	41.4	30	161.3	46.3	33	151.1	45.0	63
	14	134.9	38.5	34	174.5	52.1	53	159.0	50.9	87
	15	148.8	40.2	32	174.4	50.3	48	164.1	47.9	80
	16	148.6	40.3	33	184.4	42.3	50	170.2	44.9	83
	17	139.9	37.5	27	191.7	45.4	41	171.1	49.3	68
	Entire	144.1	39.8	217	171.9	46.1	320	160.7	45.7	537
Stork Stand (sec.)	10	23.0	34.8	14	21.3	62.6	39	21.7	56.3	53
	11	11.4	10.7	27	24.4	48.5	32	18.5	36.7	59
	12	19.5	31.4	30	18.8	32.9	38	19.1	32.0	68
	13	12.9	21.4	37	27.8	47.9	42	20.8	38.4	79
	14	20.7	50.8	34	33.6	64.9	64	29.1	60.4	98
	15	17.5	22.3	42	21.5	41.9	50	19.7	34.3	92
	16	12.9	15.0	33	13.5	16.9	49	13.3	16.1	82
	17	10.9	9.8	30	21.9	50.2	42	17.3	39.0	72
	Entire	15.7	27.3	247	23.3	48.6	356	20.2	41.4	603

TABLE 3.4. THE PERFORMANCE OF SUBJECTS WITH VISUAL IMPAIRMENTS ON RUNNING EVENTS CATEGORIZED BY SEX AND METHOD OF AMBULATION.*

Test Item and Subject Group	Subjects with Visual Impairments											
	Method of Ambulation									Total		
	Partner			Guide Wire			Unassisted					
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Shuttle Run												
Entire	14.8	4.4	43	18.8	11.2	66	13.0	3.9	462	13.8	15.6	571
Female	16.1	5.4	20	19.4	10.0	36	13.7	3.8	176	14.8	5.7	232
Male	13.7	2.9	23	18.1	12.5	30	12.3	4.0	286	13.2	5.5	339
50-Yard Dash												
Entire	10.2	3.2	30	11.0	3.6	109	8.8	1.9	452	9.3	2.5	591
Female	10.3	2.0	17	11.5	2.6	51	9.2	1.7	170	9.8	2.1	238
Male	10.0	4.4	13	10.5	4.3	58	8.6	2.0	282	8.9	2.7	353
Long Distance Run												
Entire	153.2	37.0	76	146.0	44.9	48	163.7	46.9	413	160.7	45.7	537
Female	138.8	32.1	40	136.6	41.3	22	146.6	41.4	155	144.1	39.8	217
Male	169.2	35.7	36	153.9	47.1	26	174.1	47.0	258	171.9	46.1	320
	Blind Subjects											
Shuttle Run												
Entire	15.1	4.5	36	18.8	11.1	53	15.2	6.5	39	16.7	8.5	128
Female	16.4	5.6	18	19.0	8.8	28	17.4	9.6	16	17.8	8.2	62
Male	13.9	2.8	18	18.6	13.4	25	13.7	2.0	23	15.6	8.7	66
50-Yard Dash												
Entire	9.9	2.8	26	11.2	3.9	88	9.8	1.8	27	10.6	3.4	141
Female	10.3	2.0	17	11.9	2.7	19	9.4	1.9	13	11.0	2.6	69
Male	9.1	3.9	9	10.6	4.5	49	9.2	1.8	14	10.1	4.1	72
Long Distance Run												
Entire	152.8	37.2	70	143.2	48.0	39	140.4	41.8	28	147.5	41.5	137
Female	138.5	32.5	39	129.6	44.4	17	137.7	36.8	11	136.1	36.1	67
Male	170.8	35.2	31	153.7	49.0	22	142.2	45.7	17	158.5	43.5	70

*Units of measure are in seconds for shuttle run and dash, and yards per minute for the long distance run.

TABLE 3.4. (cont.)

Test Item and Subject Group	Partially Sighted Subjects											
	Method of Ambulation									Total		
	Partner			Guide Wire			Unassisted					
	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	N
Shuttle Run												
Entire	13.2	3.2	7	78.7	11.8	13	12.8	3.6	423	13.0	4.1	443
Female	13.6	2.1	2	20.7	14.1	8	13.3	2.3	160	13.7	4.0	170
Male	13.0	3.7	5	15.5	6.7	5	12.6	4.1	263	12.6	4.2	273
50-Yard Dash												
Entire	12.1	5.3	4	10.1	2.0	21	8.8	1.9	425	8.9	2.0	450
Female	-	-	-	10.2	1.7	12	9.2	1.7	157	9.3	1.7	169
Male	12.1	5.3	4	10.1	2.4	9	8.5	2.0	268	8.6	2.2	281
Long Distance Run												
Entire	157.8	37.7	6	158.1	27.0	9	165.4	46.8	385	165.2	46.3	400
Female	150.0	-	1	160.5	13.0	5	147.3	41.7	144	147.7	41.0	150
Male	159.4	42.0	5	155.1	41.2	4	176.3	46.4	241	175.6	46.2	250

TABLE 3.5. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON INDIVIDUALS WITH AMPUTATIONS AND CONGENITAL ANOMALIES.

Variable	Age	Female			Male			Combined		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
Tricep Skinfold (mm.)	10	13.6	0.5	3	6.2	2.7	7	8.4	4.2	10
	11	14.7	0.0	1	15.1	8.1	7	15.1	7.5	8
	12	16.5	0.0	1	8.7	0.0	1	12.6	5.5	2
	13	9.8	6.4	7	12.9	9.0	5	11.1	7.3	12
	14	21.6	6.0	4	9.3	1.4	2	17.5	7.9	6
	15	20.4	7.0	3	7.5	2.4	4	13.0	8.2	7
	16	17.4	6.7	3	27.9	3.0	2	21.6	7.6	5
	17	18.0	2.4	3	16.3	9.1	7	16.8	7.6	10
	Entire	15.8	6.6	25	12.6	8.3	35	13.9	7.7	60
Abdominal Skinfold (mm.)	10	13.8	2.2	3	5.2	2.2	7	7.8	4.6	10
	11	17.0	0.0	1	19.0	15.0	7	18.8	13.9	8
	12	19.8	0.0	1	15.4	0.0	1	17.6	3.1	2
	13	11.8	6.5	7	17.4	13.2	5	14.1	9.7	12
	14	18.5	4.1	5	6.2	2.6	2	15.0	7.0	7
	15	20.5	1.6	3	6.6	1.9	4	12.6	7.6	7
	16	22.0	11.5	3	35.7	6.2	2	27.5	11.5	5
	17	14.2	6.9	3	19.3	14.4	8	17.9	12.6	11
	Entire	16.3	6.5	26	14.9	12.9	36	15.5	10.6	62
Subscapular Skinfold (mm.)	10	11.5	1.1	3	5.7	1.2	7	7.4	3.0	10
	11	14.3	0.0	1	14.8	9.1	7	14.7	8.4	8
	12	11.0	0.0	1	7.0	0.0	1	9.0	2.8	2
	13	9.2	3.9	7	9.5	6.1	5	9.3	4.7	12
	14	17.1	4.8	5	6.5	2.1	2	14.0	6.3	7
	15	17.0	6.5	3	11.3	5.9	4	13.7	6.4	7
	16	15.7	7.2	3	27.5	2.1	2	20.4	8.3	5
	17	17.0	0.9	3	15.8	10.5	8	16.1	8.8	11
	Entire	13.8	5.2	26	12.1	8.6	36	12.8	7.3	62
Sum of Triceps and Subscapular Skinfolds (mm.)	10	25.1	1.0	3	11.9	3.4	7	15.9	7.0	10
	11	29.0	0.0	1	29.9	17.0	7	29.8	15.7	8
	12	27.5	0.0	1	15.7	0.0	1	21.6	8.3	2
	13	19.0	10.2	7	22.4	14.9	5	20.4	11.8	12
	14	40.6	8.1	4	15.8	3.5	2	32.4	14.4	6
	15	37.4	13.1	3	18.8	3.8	4	26.8	12.8	7
	16	33.1	9.9	3	55.4	0.9	2	42.0	14.1	5
	17	35.0	3.2	3	33.4	18.9	7	33.9	15.5	10
	Entire	29.8	11.2	25	24.9	16.3	35	26.9	14.5	60

TABLE 3.5. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit-Ups (no.)	10	0.0	0.0	1	11.8	9.3	6	10.1	9.6	7
	11	4.0	0.0	1	12.5	12.7	6	11.3	12.0	7
	12	-	-	-	-	-	-	-	-	-
	13	4.2	8.0	6	27.0	32.5	2	9.9	17.6	8
	14	5.3	10.5	4	4.0	0.0	1	5.0	9.1	5
	15	1.5	2.1	2	16.0	0.0	1	6.3	8.5	3
	16	20.5	2.1	2	0.0	0.0	1	13.7	11.9	3
	17	19.0	0.0	1	16.0	15.6	5	16.5	14.0	6
	Entire	6.6	9.2	17	13.6	13.7	22	10.6	12.3	39
Leg Raise (sec.)	10	0.0	0.0	1	27.3	28.1	6	23.4	27.6	7
	11	1.0	0.0	1	7.8	7.9	5	6.7	7.6	6
	12	-	-	-	-	-	-	-	-	-
	13	29.7	27.2	6	13.0	18.4	2	25.5	25.2	8
	14	21.5	35.9	4	14.0	4.2	2	19.0	28.2	6
	15	7.0	0.0	2	0.0	0.0	1	4.7	4.0	3
	16	17.5	12.0	2	21.0	0.0	1	18.7	8.7	3
	17	2.0	1.4	2	16.2	20.2	5	12.1	17.9	7
	Entire	17.7	24.2	18	16.3	19.0	22	16.9	21.2	40
Trunk Raise (sec.)	10	6.0	5.6	3	6.3	6.0	6	6.2	5.5	9
	11	12.0	0.0	1	17.3	16.8	6	16.6	15.5	7
	12	-	-	-	-	-	-	-	-	-
	13	11.6	16.1	7	4.3	5.1	4	8.9	13.3	11
	14	33.0	60.2	5	30.5	29.0	2	32.3	50.5	7
	15	14.5	10.6	2	1.0	1.4	2	7.8	9.9	4
	16	11.0	0.0	1	18.0	0.0	1	14.5	4.9	2
	17	8.0	7.2	3	30.3	40.0	7	23.6	34.6	10
	Entire	15.5	29.6	22	16.1	24.0	28	15.8	26.3	50
Right Grip (kg.)	10	10.5	0.7	2	8.2	3.1	6	8.8	2.8	8
	11	-	-	-	12.6	9.0	7	12.6	9.0	7
	12	27.0	0.0	1	10.0	0.0	1	18.5	12.0	2
	13	17.0	5.9	6	19.3	12.1	4	17.9	8.3	10
	14	15.3	9.0	4	12.0	0.0	1	14.6	8.0	5
	15	25.7	15.5	3	20.5	14.9	4	22.7	14.1	7
	16	13.7	6.5	3	30.0	0.0	1	17.8	9.7	4
	17	5.0	7.1	2	34.4	11.5	5	26.0	17.4	7
	Entire	16.1	9.4	21	17.9	12.8	29	17.2	11.4	50

TABLE 3.5. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Left Grip (kg.)	10	7.5	3.5	2	8.3	4.6	7	8.1	4.2	9
	11	-	-	-	12.4	9.0	5	12.4	9.0	5
	12	27.0	0.0	1	10.0	0.0	1	18.5	12.0	2
	13	15.2	7.1	6	19.5	17.4	4	16.9	11.6	10
	14	12.3	3.9	4	7.0	0.0	1	11.2	4.1	5
	15	22.3	18.9	3	21.5	17.1	4	21.9	16.3	7
	16	10.3	14.6	3	27.0	14.1	2	17.0	15.5	5
	17	6.0	8.5	2	31.3	19.7	6	25.0	20.6	8
	Entire	13.9	10.4	21	18.1	15.2	30	16.4	13.5	51
Sum of Grips (kg.)	10	18.0	4.2	2	16.2	7.7	6	16.6	6.8	8
	11	-	-	-	26.8	18.4	5	26.8	18.4	5
	12	54.0	0.0	1	20.0	0.0	1	37.0	24.0	2
	13	32.2	11.6	6	38.8	29.1	4	34.8	19.2	10
	14	27.5	11.5	4	19.0	0.0	1	25.8	10.6	5
	15	48.0	33.8	3	42.0	31.9	4	44.6	30.0	7
	16	24.0	15.4	3	67.0	0.0	1	34.8	24.9	4
	17	11.0	15.6	2	61.6	28.4	5	47.1	34.5	7
	Entire	30.0	18.5	21	35.9	26.5	27	33.3	23.3	48
Arm Hang (sec.)	10	2.0	0.0	1	6.2	10.5	6	5.6	9.7	7
	11	-	-	-	3.8	6.5	5	3.8	6.5	5
	12	6.0	0.0	1	0.0	0.0	1	3.0	4.2	2
	13	9.6	10.4	5	4.0	4.9	4	7.1	8.4	9
	14	2.3	3.3	4	0.0	0.0	1	1.8	3.0	5
	15	0.0	0.0	2	9.5	9.7	4	6.3	9.0	6
	16	3.3	3.1	3	1.5	2.1	2	2.6	2.6	5
	17	4.5	6.4	2	10.3	10.0	3	8.0	8.4	5
	Entire	4.7	6.5	18	5.5	7.8	26	5.2	7.3	44
Pull-Ups (no.)	10	2.0	0.0	1	2.5	4.3	6	2.4	3.9	7
	11	-	-	-	1.2	1.6	5	1.2	1.6	5
	12	0.0	0.0	1	0.0	0.0	1	0.0	0.0	2
	13	3.6	5.0	5	2.8	4.9	4	3.2	4.6	9
	14	1.0	2.0	4	0.0	0.0	1	0.8	1.8	5
	15	0.0	0.0	3	4.3	7.2	4	2.4	5.6	7
	16	1.0	1.0	3	0.0	0.0	2	0.6	0.9	5
	17	0.0	0.0	2	0.5	1.0	4	0.3	0.8	6
	Entire	1.4	2.9	19	1.9	3.8	27	1.7	3.5	46

TABLE 3.5. (cont.)

Variable	Age	Female			Male			Combined		
		Mean	SD	N	Mean	SD	N	Mean	SD	N
broad Jump (inches)	10	-	-	-	36.4	16.9	5	36.4	16.9	5
	11	-	-	-	35.6	15.3	5	35.6	15.3	5
	12	-	-	-	-	-	-	-	-	-
	13	23.0	0.0	1	60.0	0.0	1	41.5	26.2	2
	14	6.5	0.7	2	36.0	0.0	1	16.3	17.0	3
	15	18.0	25.5	2	43.0	9.9	2	30.5	21.4	4
	16	43.5	10.6	2	55.0	0.0	1	47.3	10.0	3
	17	35.0	19.8	2	43.3	36.2	6	41.3	31.7	8
	Entire	25.4	18.8	9	40.8	21.9	21	36.2	21.9	30
Softball Distance (inches)	10	328.5	294.9	2	478.3	438.3	7	445.0	399.2	9
	11	-	-	-	730.7	312.1	7	730.7	312.1	7
	12	200.0	0.0	1	208.0	0.0	1	204.0	5.7	2
	13	243.4	126.9	7	1005.3	777.0	4	520.5	581.8	11
	14	288.0	171.2	4	937.0	0.0	1	417.8	325.9	5
	15	534.3	244.7	3	476.7	239.5	3	505.5	218.9	6
	16	349.0	0.0	1	711.0	673.2	2	590.3	519.9	3
	17	344.5	65.8	2	721.8	449.7	5	614.0	411.6	7
	Entire	317.7	177.0	20	669.7	457.6	30	528.9	407.9	50
Softball Velocity (feet per second)	10	119.9	147.4	2	44.9	21.7	6	63.7	68.2	8
	11	-	-	-	42.8	10.4	2	42.8	10.4	2
	12	-	-	-	22.5	0.0	1	22.5	0.0	1
	13	40.3	18.0	4	33.2	2.8	2	37.9	14.4	6
	14	32.6	6.0	2	49.3	0.0	1	38.2	10.5	3
	15	35.8	8.7	3	35.1	7.6	3	35.5	7.3	6
	16	30.5	0.0	1	57.8	0.0	1	44.2	19.3	2
	17	32.5	7.3	2	41.6	12.7	5	39.0	11.6	7
	Entire	47.8	52.0	14	41.2	14.6	21	43.8	34.2	35
50-Yard Dash (sec.)	10	18.3	7.1	2	12.9	7.7	4	14.7	7.3	6
	11	17.4	0.0	1	17.0	6.6	6	17.1	6.0	7
	12	15.6	0.0	1	-	-	-	15.6	0.0	1
	13	60.8	90.9	6	27.4	31.3	4	47.4	72.2	10
	14	20.4	9.9	3	9.8	0.0	1	17.8	9.7	4
	15	42.3	0.0	1	15.5	2.3	4	20.9	12.1	5
	16	13.7	0.0	1	23.5	0.0	1	18.6	6.9	2
	17	15.6	4.0	3	16.4	6.4	6	16.1	5.4	9
	Entire	33.2	53.7	18	17.6	12.9	26	24.0	36.0	44

TABLE 3.5. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
50-Meter Dash (sec.)	10	20.9	6.7	2	14.4	8.5	4	16.6	7.9	6
	11	-	-	-	19.2	8.0	6	19.2	8.0	6
	12	-	-	-	-	-	-	-	-	-
	13	67.8	99.3	6	29.4	33.0	4	52.4	79.0	10
	14	23.3	12.5	3	10.8	0.0	1	20.2	12.0	4
	15	47.9	0.0	1	17.3	2.3	4	23.4	13.8	5
	16	15.2	0.0	1	26.0	0.0	1	20.6	7.6	2
	17	17.3	3.5	3	17.8	6.6	6	17.6	5.5	9
	Entire	39.6	62.2	16	19.3	13.7	26	27.1	40.4	42
Rise-to-Stand (sec.)	10	-	-	-	2.3	1.4	5	2.3	1.4	5
	11	2.7	0.0	1	2.0	1.2	5	2.1	1.1	6
	12	-	-	-	-	-	-	-	-	-
	13	10.6	5.9	5	5.3	5.3	2	9.1	5.9	7
	14	7.7	2.5	2	2.4	0.6	2	5.0	3.4	4
	15	4.7	0.7	2	3.4	0.0	1	4.3	0.9	3
	16	3.2	0.2	2	1.7	0.0	1	2.7	0.9	3
	17	3.7	1.4	2	2.6	1.3	3	3.0	1.3	5
	Entire	6.7	4.7	14	2.6	1.9	19	4.3	3.9	33
Mat Creep (sec.)	10	-	-	-	8.3	6.2	6	8.3	6.2	6
	11	8.3	0.0	1	6.9	3.0	5	7.1	2.7	6
	12	-	-	-	-	-	-	-	-	-
	13	11.3	8.7	6	28.5	33.2	2	15.6	16.6	8
	14	15.0	8.4	4	5.4	2.8	2	11.8	8.3	6
	15	9.4	1.6	2	6.6	0.0	1	8.5	2.0	3
	16	3.3	1.1	2	5.4	0.0	1	4.0	1.5	3
	17	3.5	4.2	2	7.7	4.0	3	6.0	4.2	5
	Entire	9.9	7.5	17	9.3	10.8	20	9.6	9.3	37
Shuttle Run (sec.)	10	20.4	3.5	2	21.0	6.5	6	20.8	5.6	8
	11	18.5	0.0	1	19.3	5.1	7	19.2	4.7	8
	12	26.3	0.0	1	-	-	-	26.3	0.0	1
	13	39.6	31.0	6	30.8	26.8	4	36.1	28.2	10
	14	26.4	3.8	3	13.6	0.0	1	23.2	7.1	4
	15	38.7	0.0	1	19.7	3.8	4	23.5	9.1	5
	16	16.6	0.4	2	33.5	0.0	1	22.2	9.8	3
	17	15.4	3.8	3	15.9	4.3	5	15.7	3.9	8
	Entire	27.4	19.3	19	21.1	11.2	28	23.6	15.2	47

TABLE 3.5. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit and Reach (cm.)	10	-	-	-	20.8	8.6	6	20.8	8.6	6
	11	-	-	-	21.0	11.3	5	21.0	11.3	5
	12	50.0	0.0	1	-	-	-	50.0	0.0	1
	13	27.3	5.3	6	15.7	7.5	3	23.4	8.1	9
	14	22.0	9.5	3	17.0	0.0	1	20.8	8.2	4
	15	17.0	1.4	2	2.0	0.0	1	12.0	8.7	3
	16	25.5	19.1	2	27.0	2.8	2	26.3	11.2	4
	17	20.0	15.6	2	21.8	12.7	5	21.3	12.2	7
	Entire	25.3	10.9	16	20.0	9.9	23	22.2	10.5	39
Long Distance Run (Yards per Minute)	10	108.6	15.4	2	118.8	43.1	2	113.7	27.1	4
	11	80.0	0.0	1	108.4	89.1	4	102.7	78.2	5
	12	55.3	0.0	1	-	-	-	55.3	0.0	1
	13	97.4	24.4	3	70.3	50.3	2	86.6	34.0	5
	14	109.6	67.1	3	-	-	-	109.6	67.1	3
	15	-	-	-	18.8	8.8	2	18.8	8.8	2
	16	68.8	0.0	1	36.7	0.0	1	52.7	22.7	2
	17	81.4	0.0	1	97.8	74.6	3	93.7	61.5	4
	Entire	93.6	35.8	12	84.2	65.6	14	88.6	53.1	26
Stork Stand (sec.)	10	0.0	0.0	1	7.0	3.2	4	5.6	4.2	5
	11	-	-	-	21.4	44.0	5	21.4	44.0	5
	12	-	-	-	-	-	-	-	-	-
	13	5.6	8.1	5	15.0	19.8	2	8.3	11.4	7
	14	5.7	9.8	3	1.5	0.7	2	4.0	7.3	5
	15	1.0	1.4	2	1.0	0.0	1	1.0	1.0	3
	16	12.5	3.5	2	51.0	0.0	1	25.3	22.4	3
	17	5.5	2.1	2	21.4	28.0	7	17.9	25.2	9
	Entire	5.5	6.8	15	16.8	27.1	22	12.2	21.8	37

TABLE 3.6. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON INDIVIDUALS WITH CEREBRAL PALSY.

		Female			Male			Combined		
Variable	Age	Mean	SD	N	Mean	SD	N	Mean	SD	N
Triceps Skinfold (mm.)	10	15.0	8.1	22	10.8	6.3	40	12.3	7.2	62
	11	10.1	4.0	23	11.1	5.4	36	10.7	4.9	59
	12	14.1	9.7	22	11.6	5.3	22	12.9	7.8	44
	13	13.0	7.0	32	13.8	6.0	25	13.3	6.5	57
	14	14.3	6.1	27	9.8	6.6	26	12.1	6.7	53
	15	13.8	6.5	20	12.2	7.3	22	12.9	6.9	42
	16	15.3	6.6	13	9.4	4.3	23	11.5	5.9	36
	17	17.1	6.8	17	10.5	4.8	16	15.9	6.7	33
	Entire	13.9	7.1	176	11.1	5.9	210	12.4	6.6	386
Abdominal Skinfold (mm.)	10	12.6	6.2	22	9.5	7.6	40	10.6	7.3	62
	11	9.5	4.4	23	9.8	7.2	36	9.7	6.2	59
	12	13.6	10.3	22	10.2	7.5	22	11.9	9.1	44
	13	13.8	9.0	32	14.2	8.4	25	14.0	8.7	57
	14	15.9	7.6	27	11.0	10.4	26	13.5	9.3	53
	15	13.1	5.8	19	14.6	11.0	22	13.9	8.9	41
	16	16.8	7.7	12	12.2	6.2	23	13.8	7.0	35
	17	17.7	8.1	17	15.3	9.7	16	16.6	8.8	33
	Entire	13.9	7.9	174	11.7	8.6	210	12.7	8.3	384
Subscapular Skinfold (mm.)	10	10.6	6.8	22	8.5	6.2	39	9.2	6.4	61
	11	8.0	3.6	23	9.0	6.0	35	8.6	5.1	58
	12	11.3	8.7	22	9.9	6.6	22	10.6	7.7	44
	13	11.2	5.9	31	11.6	6.4	25	11.3	6.1	56
	14	11.4	4.4	27	9.8	8.6	25	10.6	6.7	52
	15	12.2	5.8	18	12.8	8.9	22	12.5	7.6	40
	16	13.6	6.0	13	10.7	3.2	23	11.8	4.5	36
	17	15.3	6.1	17	11.6	4.2	16	13.5	5.5	33
	Entire	11.4	6.2	173	10.2	6.6	207	10.7	6.4	380
Sum of Triceps and Subscapular Skinfolds (mm.)	10	25.5	14.1	22	19.4	11.7	39	21.6	12.8	61
	11	18.2	7.2	23	19.9	10.5	35	19.2	9.3	58
	12	25.4	17.9	22	21.5	11.6	22	23.4	15.0	44
	13	24.4	12.1	31	25.3	11.4	25	24.8	11.7	56
	14	25.7	9.7	27	19.9	13.5	25	22.9	11.9	52
	15	26.0	12.5	18	24.9	14.4	22	25.4	13.4	40
	16	29.0	11.9	13	20.0	6.7	23	23.3	9.8	36
	17	32.4	11.6	17	22.0	7.9	16	27.4	11.1	33
	Entire	25.3	12.7	173	21.3	11.3	207	23.2	12.1	380

TABLE 3.6. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit-Ups	10	10.1	12.7	19	9.3	13.3	33	9.6	13.0	52
(no.)	11	8.1	7.1	18	9.7	9.2	27	9.1	8.4	45
	12	7.1	9.6	15	7.8	9.1	15	7.4	9.2	30
	13	5.2	7.9	23	6.4	9.0	21	5.8	8.4	44
	14	5.1	8.2	19	12.5	10.3	20	8.9	9.9	39
	15	1.4	3.3	14	6.2	8.5	18	4.1	7.0	32
	16	3.4	7.9	9	7.7	9.3	19	6.3	9.0	28
	17	4.9	7.7	13	6.1	9.9	14	5.5	8.8	27
	Entire	5.9	8.7	130	8.5	10.2	167	7.4	9.7	297
Leg Raise	10	9.3	12.3	17	11.2	22.7	30	10.5	19.4	47
(sec.)	11	8.3	7.7	17	8.1	11.6	27	8.2	10.2	44
	12	6.4	8.9	16	13.8	24.7	16	10.1	18.7	32
	13	7.7	9.4	24	2.7	5.7	19	5.5	8.2	43
	14	8.9	13.4	18	13.2	15.6	17	11.0	14.5	35
	15	9.8	7.9	14	6.8	6.0	17	8.1	7.0	31
	16	14.9	22.6	10	6.7	6.4	18	9.6	14.6	28
	17	3.8	4.8	13	19.2	35.0	12	11.2	25.2	25
	Entire	8.4	11.2	129	9.7	17.9	156	9.1	15.3	285
Trunk Raise	10	42.3	67.3	12	16.1	11.6	16	27.3	45.7	28
(sec.)	11	19.2	20.6	10	22.5	26.6	11	20.9	23.4	21
	12	13.1	27.2	8	10.8	8.1	5	12.2	21.3	13
	13	14.0	13.6	6	9.1	12.6	7	11.4	12.7	13
	14	28.9	20.6	7	13.0	11.4	11	19.2	17.0	18
	15	18.0	29.9	7	28.0	23.3	4	21.6	26.9	11
	16	7.0	9.6	3	14.9	12.5	9	12.9	12.0	12
	17	7.3	7.6	6	5.8	6.9	5	6.6	7.0	11
	Entire	21.7	36.3	59	15.3	15.8	68	18.3	27.4	127
Right Grip	10	5.7	7.2	17	6.8	6.2	30	6.4	6.5	47
(kg.)	11	6.7	4.3	18	8.8	7.2	26	8.0	6.2	44
	12	10.7	7.5	18	10.8	7.7	18	10.8	7.5	36
	13	13.7	9.8	22	15.1	8.9	22	14.4	9.3	44
	14	14.1	9.0	21	15.0	9.7	20	14.6	9.2	41
	15	10.9	7.8	16	16.8	11.4	19	14.1	10.2	35
	16	15.5	8.1	11	23.8	11.1	22	21.0	10.8	33
	17	15.8	5.3	14	22.9	13.1	14	19.4	10.5	28
	Entire	11.5	8.3	137	14.2	10.8	171	13.0	9.9	308

TABLE 3.6. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Left Grip (kg.)	10	5.0	5.1	18	8.8	6.3	32	7.4	6.1	50
	11	6.5	5.4	19	8.6	6.2	26	7.7	5.9	45
	12	9.3	6.7	19	11.5	7.1	17	10.4	6.9	36
	13	13.5	7.7	27	12.3	9.5	22	13.0	8.4	49
	14	12.0	10.8	21	15.1	14.7	20	13.5	12.8	41
	15	9.1	7.7	17	18.9	9.1	19	14.3	9.7	36
	16	16.9	8.1	9	19.7	13.0	22	18.9	11.7	31
	17	15.4	8.4	14	24.2	11.8	14	19.8	11.0	28
	Entire	10.6	8.3	144	14.0	10.9	172	12.4	9.9	316
Sum of Grips (kg.)	10	9.3	11.4	16	15.4	10.8	30	13.3	11.3	46
	11	12.6	8.3	18	17.0	12.5	24	15.1	11.0	42
	12	19.7	13.4	18	22.2	13.9	17	20.9	13.5	35
	13	27.3	15.4	21	26.8	17.1	21	27.0	16.0	42
	14	26.1	18.7	21	29.7	16.9	19	27.8	17.8	40
	15	19.6	13.6	16	35.7	15.9	19	28.4	16.8	35
	16	34.0	15.2	9	43.5	22.5	22	40.7	20.9	31
	17	31.1	12.2	14	46.1	24.2	13	38.3	20.0	27
	Entire	21.9	15.6	133	27.9	19.5	165	25.2	18.1	298
Arm Hang (sec.)	10	1.2	3.1	14	1.7	3.3	20	1.5	3.2	34
	11	1.2	1.9	13	3.1	6.7	22	2.4	5.5	35
	12	3.1	5.0	11	5.1	10.2	14	4.2	8.2	25
	13	2.5	4.5	11	4.2	8.6	13	3.5	6.9	24
	14	1.0	1.7	13	4.1	4.9	16	2.7	4.1	29
	15	0.9	2.0	9	4.3	5.4	15	3.0	4.7	24
	16	2.3	2.3	6	11.4	15.7	12	8.4	13.4	18
	17	0.9	1.6	11	7.7	10.7	9	4.0	7.8	20
	Entire	1.6	3.1	88	4.7	8.5	121	3.4	6.9	209
Pull-Ups (no.)	10	0.2	0.8	14	0.4	0.8	20	0.3	0.8	34
	11	0.2	0.6	13	0.8	1.9	22	0.5	1.6	35
	12	1.4	2.9	12	0.9	1.7	14	1.2	2.3	26
	13	0.5	0.8	11	1.5	3.2	13	1.0	2.4	24
	14	0.0	0.0	13	0.8	1.5	16	0.4	1.2	29
	15	0.1	0.3	10	2.6	4.6	15	1.6	3.7	25
	16	0.2	0.4	6	2.2	3.8	13	1.6	3.2	19
	17	0.3	0.6	11	1.9	3.2	8	0.9	2.3	19
	Entire	0.4	1.2	90	1.3	2.7	121	0.9	2.3	211

TABLE 3.6 . (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Broad Jump (inches)	10	26.5	10.2	11	32.2	12.5	15	29.8	11.7	26
	11	27.3	14.5	11	26.0	12.9	12	26.6	13.4	23
	12	30.8	17.0	6	27.6	18.4	7	29.0	17.1	13
	13	23.6	14.2	7	35.6	11.5	8	30.0	13.8	15
	14	22.6	21.5	8	40.3	13.6	12	33.3	18.9	20
	15	30.0	14.1	7	37.5	14.8	4	32.7	14.1	11
	16	22.5	31.8	2	30.4	13.7	9	29.0	16.2	11
	17	27.0	14.9	7	39.8	12.9	4	31.6	15.0	11
	Entire	26.5	15.0	59	33.0	13.9	71	30.0	14.7	130
Softball Distance (inches)	10	231.5	131.4	16	308.8	281.4	31	282.5	242.2	47
	11	232.9	134.6	19	338.3	177.1	28	295.7	168.0	47
	12	182.0	108.7	17	343.8	208.2	16	260.4	181.5	33
	13	253.6	128.0	27	407.0	311.6	22	322.5	239.4	49
	14	244.4	209.5	21	424.1	264.7	18	327.3	250.4	39
	15	168.9	79.7	14	520.5	447.0	14	344.7	362.3	28
	16	235.4	146.8	11	461.5	310.4	19	378.6	282.0	30
	17	301.1	216.0	14	388.1	227.1	13	343.0	221.6	27
	Entire	232.9	151.4	139	386.5	282.0	161	315.3	243.0	300
Softball Velocity (feet per second)	10	25.3	7.6	10	39.2	39.6	17	34.1	32.1	27
	11	31.6	12.8	15	31.9	9.7	19	31.8	11.0	34
	12	26.4	15.3	10	31.9	13.6	7	28.7	14.5	17
	13	39.0	57.1	16	32.2	13.8	17	35.5	40.5	33
	14	27.4	13.6	14	42.8	35.1	16	35.6	27.9	30
	15	25.0	11.9	12	32.6	16.9	11	28.6	14.7	23
	16	23.3	7.5	9	35.6	14.6	11	30.1	13.2	20
	17	29.8	11.2	12	35.2	11.7	9	32.1	11.4	21
	Entire	29.2	25.3	98	35.5	23.2	107	32.5	24.4	205
50-Yard Dash (sec.)	10	25.9	18.3	13	30.7	31.3	29	29.2	27.8	42
	11	23.6	17.1	15	23.5	11.5	25	23.5	13.7	40
	12	41.7	34.3	18	31.5	35.7	16	36.9	34.9	34
	13	56.7	54.0	21	24.7	17.6	17	42.4	44.4	38
	14	36.9	25.7	21	33.3	47.4	18	35.3	36.8	39
	15	51.7	64.3	12	25.4	17.5	13	38.0	47.2	25
	16	119.3	225.2	10	37.9	42.5	16	69.2	144.8	26
	17	51.8	59.2	12	28.8	19.4	10	41.4	46.2	22
	Entire	47.9	76.7	122	29.3	30.2	144	37.8	57.1	266

TABLE 3.6. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
50-Meter Dash (sec.)	10	31.0	20.9	12	35.3	36.1	29	34.0	32.2	41
	11	26.7	19.6	14	25.2	11.5	23	25.8	14.9	37
	12	46.2	35.3	18	35.1	39.5	16	41.0	37.2	34
	13	69.2	65.3	19	27.9	19.2	17	49.7	52.9	36
	14	47.4	38.6	19	37.9	54.4	17	42.9	46.3	36
	15	57.7	71.1	12	28.4	19.4	13	42.4	52.3	25
	16	141.1	277.9	10	42.0	47.7	16	80.1	177.7	26
	17	59.7	75.4	13	31.7	22.0	10	47.5	59.2	23
	Entire	57.0	95.2	117	32.9	34.1	141	43.8	69.8	258
Rise-to-Stand (sec.)	10	3.6	1.9	12	2.5	0.7	16	3.0	1.4	28
	11	2.9	0.7	11	3.3	1.6	13	3.1	1.3	24
	12	3.7	2.2	9	3.5	1.5	7	3.6	1.8	16
	13	3.1	0.7	8	2.7	1.3	8	2.9	1.0	16
	14	12.9	22.6	7	3.2	2.7	13	6.6	13.7	20
	15	4.1	2.1	9	2.9	1.1	4	3.8	1.9	13
	16	5.2	2.2	4	3.1	1.3	7	3.9	1.9	11
	17	5.7	3.1	7	4.7	2.3	6	5.3	2.7	13
	Entire	4.8	7.6	67	3.1	1.7	74	3.9	5.4	141
Mat Creep (sec.)	10	13.6	15.0	18	15.9	15.5	32	15.1	15.2	50
	11	12.0	11.2	18	11.3	6.7	28	11.6	8.6	46
	12	15.7	16.3	18	12.8	12.7	18	14.3	14.5	36
	13	14.5	11.6	21	10.0	7.6	18	12.4	10.1	39
	14	21.5	16.5	19	13.9	19.2	18	17.8	18.0	37
	15	15.6	15.1	13	10.5	5.2	16	12.7	10.9	29
	16	14.1	10.3	9	16.0	13.5	16	15.3	12.3	25
	17	31.3	44.2	11	17.1	21.3	11	24.2	34.6	22
	Entire	16.8	18.8	127	13.4	13.2	157	14.9	16.0	284
Shuttle Run (sec.)	10	25.7	18.0	14	40.7	34.7	32	36.1	31.2	46
	11	28.2	16.5	16	26.8	14.8	25	27.3	15.3	41
	12	46.8	31.3	19	34.3	36.6	17	40.9	34.0	36
	13	52.2	39.7	20	34.9	22.1	20	43.6	32.9	40
	14	42.8	23.4	20	46.0	68.2	18	44.3	49.2	38
	15	45.6	31.4	12	35.8	25.8	14	40.3	28.4	26
	16	44.2	22.3	11	37.2	26.3	16	40.0	24.5	27
	17	49.2	39.4	12	39.7	25.7	13	44.3	32.6	25
	Entire	42.1	29.8	124	36.7	34.6	155	39.1	32.6	279

TABLE 3.6. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Sit and Reach (cm.)	10	18.1	10.9	11	15.5	7.1	20	16.4	8.5	31
	11	18.8	9.7	12	17.7	9.8	15	18.1	9.6	27
	12	13.5	7.2	11	21.0	9.5	11	17.3	9.1	22
	13	25.4	14.1	11	21.2	8.8	11	23.3	11.7	22
	14	24.1	18.1	8	16.3	11.6	15	19.0	14.3	23
	15	17.7	13.9	10	18.6	12.5	8	18.1	12.9	18
	16	13.5	15.5	4	10.8	7.1	13	11.4	9.2	17
	17	20.4	9.0	9	22.5	9.4	6	21.3	8.9	15
	Entire	19.2	12.3	76	17.2	9.6	99	18.1	10.9	175
Long Distance Run (yards per minute)	10	93.1	32.9	9	96.4	43.2	15	95.2	39.0	24
	11	71.3	36.6	7	89.9	32.9	16	84.3	34.4	23
	12	79.7	43.9	9	76.3	20.9	8	78.1	34.0	17
	13	84.7	19.2	5	87.6	52.1	12	86.7	44.3	17
	14	63.5	30.8	7	97.9	53.1	14	86.4	48.9	21
	15	52.2	29.9	8	77.8	50.8	8	65.0	42.4	16
	16	48.9	24.7	4	83.0	65.3	10	73.3	57.9	14
	17	81.8	36.8	11	76.3	52.8	8	79.5	42.9	19
	Entire	73.9	35.1	60	87.7	46.4	91	82.2	42.7	151
Stork Stand (sec.)	10	7.0	7.5	11	7.3	9.4	16	7.1	8.5	27
	11	14.3	35.1	10	7.5	8.1	12	10.6	24.0	22
	12	14.3	20.4	6	18.8	33.3	6	16.6	26.4	12
	13	1.0	1.4	2	28.5	39.4	8	23.0	36.7	10
	14	2.2	1.5	5	3.0	0.9	10	2.7	1.2	15
	15	5.7	9.2	7	48.0	74.1	4	21.1	46.4	11
	16	1.5	0.7	2	4.7	4.7	7	4.0	4.3	9
	17	1.5	1.0	6	7.5	13.0	4	3.9	8.2	10
	Entire	7.6	18.0	49	12.4	26.1	67	10.4	23.1	116

TABLE 3.7. PERFORMANCE OF SUBJECTS WITH CEREBRAL PALSY ON RUNNING EVENTS CATEGORIZED BY SEX AND METHOD OF AMBULATION.

Method of Ambulation	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N
50-Yard Dash (sec.)						
Wheelchair	96.9	125.1	36	56.8	45.5	34
Other Assistive Device	40.3	26.6	26	33.6	21.7	35
Unassisted	19.8	9.9	58	14.7	7.1	74
Total	47.4	76.9	120	29.3	30.3	143
Shuttle Run (sec.)						
Wheelchair	73.0	29.3	34	69.7	42.3	34
Other Assistive Device	44.6	25.4	26	46.8	37.8	38
Unassisted	24.9	14.5	63	18.2	6.6	81
Total	42.3	29.8	123	36.8	34.8	153
Long Distance Run (Yards Per Minute)						
Wheelchair	51.1	34.0	18	46.9	25.7	17
Other Assistive Device	54.9	23.6	16	57.4	26.7	28
Unassisted	74.8	39.2	40	107.2	45.1	56
Total	64.7	36.4	74	83.3	46.4	101

TABLE 3.8. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED ON INDIVIDUALS WITH SPINAL NEUROMUSCULAR IMPAIRMENTS.*

		Female			Male			Combined		
Variable	Age	Mean	SD	N	Mean	SD	N	Mean	SD	N
Tricep Skinfold (mm.)	10	12.4	5.0	16	17.2	5.8	13	14.5	5.8	29
	11	13.7	7.8	14	13.6	3.4	9	13.7	6.4	23
	12	14.6	7.4	10	14.7	6.2	10	14.6	6.6	20
	13	14.4	7.4	6	19.6	10.3	7	17.2	9.1	13
	14	18.2	8.3	5	9.9	5.4	7	13.4	7.6	12
	15	21.7	6.6	11	12.6	5.8	10	17.3	7.6	21
	16	21.8	10.1	6	23.2	13.9	5	22.4	11.3	11
	17	16.5	5.9	5	12.1	5.3	11	13.5	5.7	16
	Entire	16.0	7.6	73	14.9	7.4	72	15.4	7.5	145
Abdominal Skinfold (mm.)	10	14.5	7.7	15	17.1	7.1	12	15.7	7.4	27
	11	12.3	7.8	14	17.3	8.4	8	14.1	8.2	22
	12	16.2	8.7	10	14.6	5.4	9	15.4	7.2	19
	13	15.5	8.8	5	15.9	9.2	6	15.7	8.6	11
	14	18.8	16.6	5	12.7	7.3	6	15.5	12.2	11
	15	19.2	17.4	10	19.9	12.1	8	19.5	14.9	18
	16	25.3	14.3	6	29.5	11.6	5	27.2	12.7	11
	17	25.6	17.4	5	14.2	6.4	10	18.0	12.0	15
	Entire	17.1	12.0	70	17.1	8.9	64	17.1	10.6	134
Subscapular Skinfold (mm.)	10	9.9	5.0	15	13.7	5.4	12	11.6	5.4	27
	11	11.1	6.6	14	12.0	4.7	8	11.5	5.9	22
	12	13.8	8.5	10	13.8	6.0	9	13.8	7.2	19
	13	9.8	4.0	6	16.3	10.3	7	13.3	8.4	13
	14	16.9	11.9	5	9.5	4.5	7	12.6	8.8	12
	15	15.6	11.8	11	14.8	8.2	9	15.3	10.1	20
	16	21.5	8.6	6	26.0	13.6	5	23.5	10.8	11
	17	18.5	10.4	5	12.6	5.1	10	14.6	7.5	15
	Entire	13.6	8.7	72	14.3	7.8	67	13.9	8.2	139
Sum of Triceps and Subscapular Skinfolds (mm.)	10	22.0	9.8	15	31.5	10.3	12	26.2	10.9	27
	11	24.9	14.0	14	25.4	8.1	8	25.1	12.0	22
	12	28.3	15.5	10	29.0	10.9	9	28.7	13.1	19
	13	24.2	11.2	6	35.9	19.9	7	30.5	17.0	13
	14	35.1	20.1	5	19.4	9.7	7	25.9	16.2	12
	15	37.2	17.3	11	28.3	11.2	9	33.2	15.2	20
	16	43.3	18.3	6	49.2	27.3	5	46.0	21.8	11
	17	35.1	15.8	5	25.6	8.0	10	28.7	11.6	15
	Entire	29.5	15.6	72	29.6	14.2	67	29.6	14.9	139

*Data presented relative to skinfold and softball test items include all subjects classified as spinal neuromuscular. Data pertaining to grip strength, flexed arm hang, and pull-ups include all subjects classified as spinal neuromuscular, except for quadriplegics. Data pertaining to the 50-yard and 50-meter dashes, shuttle run, and long distance run include only subjects classified as spinal neuromuscular and who performed these test items in wheelchairs.

TABLE 3.8. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Right Grip (kg.)	10	9.2	6.6	15	10.1	5.9	13	9.6	6.2	28
	11	11.9	6.0	13	15.2	4.5	9	13.3	5.5	22
	12	11.7	7.4	10	28.0	18.7	10	19.9	16.2	20
	13	15.0	6.8	5	23.4	9.9	7	19.9	9.5	12
	14	12.0	9.7	5	24.8	10.7	5	18.4	11.8	10
	15	22.8	6.7	10	26.0	13.5	10	24.4	10.5	20
	16	19.8	4.3	6	45.4	12.9	5	31.5	15.9	11
	17	26.7	14.5	3	31.0	10.7	9	29.9	11.2	12
	Entire	14.5	8.6	67	23.6	14.5	68	19.1	12.8	135
Left Grip (kg.)	10	8.1	5.9	15	9.2	6.1	13	8.6	5.9	28
	11	11.2	5.2	13	13.4	5.4	9	12.1	5.3	22
	12	11.0	7.8	10	24.1	18.7	10	17.6	15.5	20
	13	12.8	5.7	5	21.0	13.0	7	17.6	11.0	12
	14	12.2	12.4	5	18.8	11.3	6	15.8	11.7	11
	15	19.7	6.9	10	23.5	15.1	10	21.6	11.6	20
	16	18.7	5.5	6	42.2	12.9	5	29.4	15.3	11
	17	24.7	12.7	3	29.6	10.9	9	28.3	11.0	12
	Entire	13.2	8.3	67	21.1	14.6	69	17.2	12.5	136
Sum of Grips (kg.)	10	17.3	12.4	15	19.3	11.8	13	18.2	12.0	28
	11	23.1	10.6	13	28.7	9.3	9	25.4	10.2	22
	12	22.7	14.8	10	52.1	37.1	10	37.4	31.4	20
	13	27.8	12.3	5	44.4	22.6	7	37.5	20.2	12
	14	24.2	21.3	5	45.6	22.0	5	34.9	23.3	10
	15	42.5	13.3	10	49.5	28.3	10	46.0	21.8	20
	16	38.5	8.2	6	87.6	25.1	5	60.8	30.7	11
	17	51.3	27.2	3	60.6	21.1	9	58.3	21.8	12
	Entire	27.7	16.5	67	44.8	28.9	68	36.3	25.0	135
Arm Hang (sec.)	10	3.1	5.1	12	2.0	4.9	11	2.6	4.9	23
	11	4.9	5.8	13	5.1	8.8	8	5.0	6.8	21
	12	1.8	2.7	8	8.9	11.1	8	5.3	8.6	16
	13	6.7	11.5	3	7.0	8.6	5	6.9	9.0	8
	14	1.8	2.5	5	5.4	7.6	5	3.6	5.7	10
	15	4.8	5.5	9	6.8	5.7	9	5.8	5.5	18
	16	0.3	0.5	4	13.3	7.4	3	5.9	8.2	7
	17	0.0	0.0	3	8.7	8.1	7	6.1	7.8	10
	Entire	3.3	5.1	57	6.4	7.8	56	4.8	6.8	113

TABLE 3.8. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
Pull-Ups (no.)	10	1.3	2.3	12	0.5	1.0	11	0.9	1.8	23
	11	1.6	2.4	11	1.1	0.8	8	1.4	1.9	19
	12	1.1	1.8	8	1.9	2.3	8	1.5	2.0	16
	13	0.0	0.0	3	2.8	4.3	4	1.6	3.4	7
	14	0.0	0.0	5	3.8	5.3	5	1.9	4.1	10
	15	0.6	1.3	10	2.8	2.9	9	1.6	2.4	19
	16	0.0	0.0	4	3.7	3.2	3	1.6	2.7	7
	17	1.0	1.0	3	3.4	3.2	7	2.7	2.9	10
	Entire	0.9	1.8	56	2.2	2.9	55	1.5	2.5	111
Softball Distance (inches)	10	183.4	90.0	16	221.1	86.8	13	200.3	89.1	29
	11	206.4	98.5	13	415.1	195.2	8	285.9	173.0	21
	12	239.5	173.9	10	549.3	325.3	10	394.4	299.5	20
	13	246.0	139.7	6	432.1	281.0	7	346.2	238.6	13
	14	185.8	102.1	5	375.3	320.5	8	302.4	269.5	13
	15	263.5	62.8	10	397.2	249.3	10	330.4	189.7	20
	16	205.2	69.2	6	651.8	374.8	5	408.2	336.1	11
	17	188.6	105.7	5	391.7	234.1	9	319.1	217.6	14
	Entire	214.5	107.8	71	406.7	270.0	70	309.9	225.9	141
Softball Velocity (feet per second)	10	24.2	5.5	13	23.7	5.5	9	24.0	5.3	22
	11	24.7	7.9	9	38.2	13.7	7	30.6	12.5	16
	12	22.6	8.9	9	34.6	12.1	8	28.3	11.9	17
	13	34.5	29.3	6	32.4	12.0	6	33.4	21.4	12
	14	21.2	8.1	5	31.4	14.4	4	25.7	11.8	9
	15	25.9	4.0	9	29.6	6.7	8	27.6	5.6	17
	16	21.7	5.4	5	41.8	15.2	3	29.2	13.8	8
	17	24.4	9.2	5	32.2	9.4	7	28.9	9.8	12
	Entire	24.9	11.1	61	32.0	11.1	52	28.2	11.6	113
50-Yard Dash (sec.)	10	37.4	17.4	7	27.2	8.0	10	31.4	13.3	17
	11	21.9	2.6	7	22.3	4.4	6	22.1	3.4	13
	12	21.3	3.5	5	21.6	6.5	8	21.5	5.3	13
	13	40.7	9.6	3	28.9	21.0	4	33.9	17.0	7
	14	22.9	6.0	4	75.7	105.6	5	52.2	79.8	9
	15	23.0	7.5	10	56.7	96.4	7	36.9	61.7	17
	16	24.1	2.5	5	16.8	2.0	4	20.8	4.4	9
	17	46.5	23.6	4	19.5	2.2	7	29.3	18.9	11
	Entire	28.3	13.3	45	32.8	49.0	51	30.7	36.8	96

TABLE 3.8. (cont.)

Variable	Age	Female Mean	Female SD	Female N	Male Mean	Male SD	Male N	Combined Mean	Combined SD	Combined N
50-Meter Dash (sec.)	10	33.2	7.9	7	31.1	11.2	10	32.0	9.7	17
	11	24.0	3.3	7	25.2	5.7	4	24.4	4.1	11
	12	22.5	4.1	4	21.1	6.2	6	21.7	5.3	10
	13	50.9	17.0	3	31.3	19.8	4	39.7	20.1	7
	14	25.0	7.1	4	93.9	117.7	4	59.4	85.5	8
	15	28.0	7.6	9	65.7	109.3	7	44.4	72.0	16
	16	26.9	2.9	5	18.2	0.2	2	24.4	4.9	7
	17	49.7	24.3	4	21.4	2.9	7	31.7	19.7	11
	Entire	30.9	13.0	43	38.3	56.9	44	34.6	41.4	87
Shuttle Run (sec.)	10	37.7	10.3	8	34.7	8.0	10	36.1	8.9	18
	11	28.7	6.6	8	30.0	7.3	6	29.3	6.7	14
	12	27.6	4.0	5	28.3	6.2	9	28.0	5.3	14
	13	51.5	10.5	3	35.3	20.6	4	42.2	18.0	7
	14	30.8	5.5	4	57.9	33.8	6	47.0	29.0	10
	15	30.5	7.4	10	63.5	88.1	7	44.1	56.7	17
	16	36.7	6.1	5	24.6	1.7	4	31.3	7.8	9
	17	46.0	29.5	5	32.3	8.7	9	37.2	19.0	14
	Entire	34.7	13.0	48	38.2	34.6	55	36.6	26.7	103
Long Distance Run (yards per minute)	10	68.0	32.5	7	83.9	33.6	9	77.0	33.0	16
	11	82.2	20.2	5	75.2	34.1	6	78.4	27.5	11
	12	95.9	18.7	5	111.0	27.3	6	104.2	23.9	11
	13	48.9	35.3	3	84.7	40.0	3	66.8	39.0	6
	14	70.5	42.1	4	48.5	43.3	3	61.1	40.6	7
	15	79.0	29.3	9	75.1	35.1	6	77.4	30.6	15
	16	76.6	28.4	5	111.9	0.0	1	82.4	29.2	6
	17	60.4	25.9	5	79.9	38.1	7	71.7	33.7	12
	Entire	74.2	29.3	43	82.8	35.5	41	78.4	32.5	84

TABLE 3.9. MEANS AND STANDARD DEVIATIONS OF PROJECT UNIQUE TEST ITEMS OBTAINED BY SUBJECTS CLASSIFIED AS SPINAL NEUROMUSCULAR-PARAPLEGIC.

Test Item	Female			Male			Total		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Triceps Skinfold (mm.)	16.1	8.0	57	15.2	6.8	54	15.7	7.4	111
Abdominal Skinfold (mm.)	17.5	12.9	54	17.8	8.3	47	17.6	10.9	101
Subscapular Skinfold (mm.)	13.9	8.9	56	14.4	6.9	50	14.1	8.0	106
Sum of Triceps and Subscapular Skinfolds (mm.)	30.0	16.1	56	30.2	12.5	50	30.1	14.4	106
Shuttle Run (sec.)	32.7	10.9	53	35.1	33.6	53	33.9	24.9	106
Right Grip (kg.)	14.6	9.0	56	23.1	14.5	56	18.8	12.8	112
Left Grip (kg.)	13.4	8.8	56	21.0	14.7	56	17.2	12.6	112
Sum of Grips (kg.)	27.9	17.5	56	44.1	28.9	56	36.0	25.1	112
Flexed Arm Hang (sec.)	2.5	4.2	48	5.7	7.4	45	4.1	6.2	93
Pull-Ups (no.)	0.8	1.6	46	2.1	2.7	45	1.4	2.3	91
50-Yard Dash (sec.)	26.8	10.1	53	29.2	37.1	51	28.0	26.8	104
50-Meter Dash (sec.)	29.7	11.0	51	33.9	42.3	44	31.6	31.7	95
Softball Distance (in.)	202.8	94.9	56	390.0	233.4	53	293.8	199.1	109
Softball Velocity (ft. per sec.)	24.3	11.9	47	31.6	11.0	42	27.7	12.0	89
Long Distance Run (Yards per min.)	823.0	319.7	46	871.3	357.4	42	846.1	337.1	88

Physical Fitness Test Performance as a Function of Condition, Sex, and Age

In this section the influence of condition, age, and sex differences on physical fitness, as determined through multivariate and univariate analysis of variance techniques, is presented. Since normal, auditory impaired, and visually impaired subjects were designated to take the same test items (see participation guide), their data were analyzed together. Performance data on the cerebral palsy and spinal neuromuscular groups were analyzed and are presented separately. These latter two groups of subjects were compared with normal subjects only. Comparisons were made between normal and orthopedic impaired subjects only on items where procedures were reasonably similar. For instance, comparisons were not made on running items since many orthopedic impaired subjects used wheelchairs or other assistive devices. Minor procedural differences (e.g., cerebral palsied subject could not cross arms on chest properly for sit-up test) were allowed for the purposes of data analysis.

Multivariate analysis of variance procedures were employed for the normal, auditory impaired, visually impaired, and spinal neuromuscular groups. Multivariate procedures were not utilized with the cerebral palsied group due to the fact that the participation guide dictated that different and very specific classes of cerebral palsied subjects took different items, thereby obviating a multivariate approach. Univariate analysis of variance was employed as the post hoc test when significant multivariate F ratios were calculated. It should be noted, however, that the univariate ANOVAs were calculated separately from the multivariate statistics. This was done so that all subjects who took an item could be included in the analysis of that item regardless of whether or not they had taken the remaining items in the battery. The result of this approach was that the univariate statistics were calculated on a somewhat different group of subjects than were the multivariate statistics; however, a greater number of subjects were available for the univariate analysis.

The .05 level of significance was adopted for use with all multivariate ANOVA procedures. In the univariate analysis, the .01 level of significance was adopted for use to help reduce experimentwise-error.

Graphic analysis (means were plotted with 99 percent confidence intervals) and the Scheffe' multiple comparison procedure were used for other post hoc contrasts. Graphic analysis was used to help explain main effects in the presence of significant interaction, while the Scheffe' procedure was used to explain main effects in the absence of significant interaction. The Scheffe' procedure was selected because it is appropriate for unequal cell sizes. Since the Scheffe' procedure is more conservative than other multiple comparison techniques, the .05 level of significance was adopted instead of the more rigorous .01. This would seem to be consistent with Ferguson's (1971) suggestion.

Comparisons of Normal, Auditory Impaired, and Visually Impaired Groups/Conditions

A three-way analysis of variance design was used to investigate the effects of condition, age, and sex on the normal, auditory impaired, and visually impaired subjects. The results of the multivariate ANOVA yielded a significant sex by age by condition interaction ($p < .000$). Since the multivariate ANOVA indicated an "interaction model," the post hoc univariate

analysis was performed. The results of the three-way univariate ANOVA tests are presented in Table 3.10.

TABLE 3.10. UNIVARIATE F VALUES FOR NORMAL, AUDITORY IMPAIRED, AND VISUALLY IMPAIRED SUBJECTS BY SEX, AGE, AND CONDITION.

Test Item	Sex	Age	Cond.	Sex X Age	Sex X Cond.	Age X Cond.	Sex X Age X Cond.
Triceps Skinfold	102.87*	3.66*	16.80*	8.32*	15.92*	1.17	.74
Abdominal Skinfold	18.71*	9.43*	16.84*	1.94	1.98	1.67	1.31
Subscapular Skinfold	40.89*	14.33*	26.00*	2.31	.01	1.65	1.23
Sit-Ups	231.08*	16.57*	134.65*	2.71*	2.55	1.40	1.46
Leg Raise	78.84*	30.91*	33.55*	4.33*	.03	1.10	.53
Trunk Raise	.12	5.66*	59.61*	1.56	1.85	.97	.79
Mat Creep	72.44*	2.73*	46.17*	1.34	2.98	1.07	.47
Shuttle Run	83.71*	18.00*	199.36*	3.01*	2.62	1.92	3.12*
Sit and Reach	111.51*	13.95*	32.36*	1.70	14.70*	1.56	.61
Right Grip	538.84*	244.42*	96.24*	41.98*	3.29	5.20*	1.07
Left Grip	503.92*	222.25*	78.44*	44.49*	3.59	5.27*	.40
Arm Hang	283.81*	6.35*	25.31*	5.25*	3.39	5.13*	1.64
Pull-Ups	698.06*	23.77*	7.81*	28.20*	6.14*	1.03	.82
50-Yard Dash	165.95*	48.61*	172.87*	7.79*	1.97	1.90	1.55
Broad Jump	587.54*	102.88*	138.50*	19.87*	.33	.81	1.43
Softball Throw (Distance)	1213.30*	99.97*	261.17*	19.13*	30.10*	2.08*	2.12*
Long Distance Run	334.76*	12.00*	69.63*	7.24*	6.15*	.56	.97

*Significant at the .01 level.

The results of the univariate ANOVA presented in Table 3.10 are discussed below for each test item.

Triceps Skinfold

Results which emerged relative to triceps skinfold are depicted in Figures 3.1A and 3.2A. A significant sex factor emerged for the triceps skinfold due to the fact that girls had significantly larger skinfolds than boys between the ages of 14 and 17. The scores of the auditory impaired and visually impaired subjects evidently contributed the most to these differences since no overall difference was observed between normal boys and normal girls on the triceps measure. Auditory impaired and visually impaired girls had larger triceps skinfold measures than normal girls. There was no significant difference in triceps skinfold of the auditory impaired and the visually impaired female subject groups. Condition was not a significant factor for boys; no significant differences emerged among the three groups of male subjects. Age was a significant factor for both sexes, although after ages 11 or 12, girls tended to have larger skinfolds and boys smaller skinfolds. For instance, girls between the ages of 13 and 17 had significantly larger skinfolds than 10

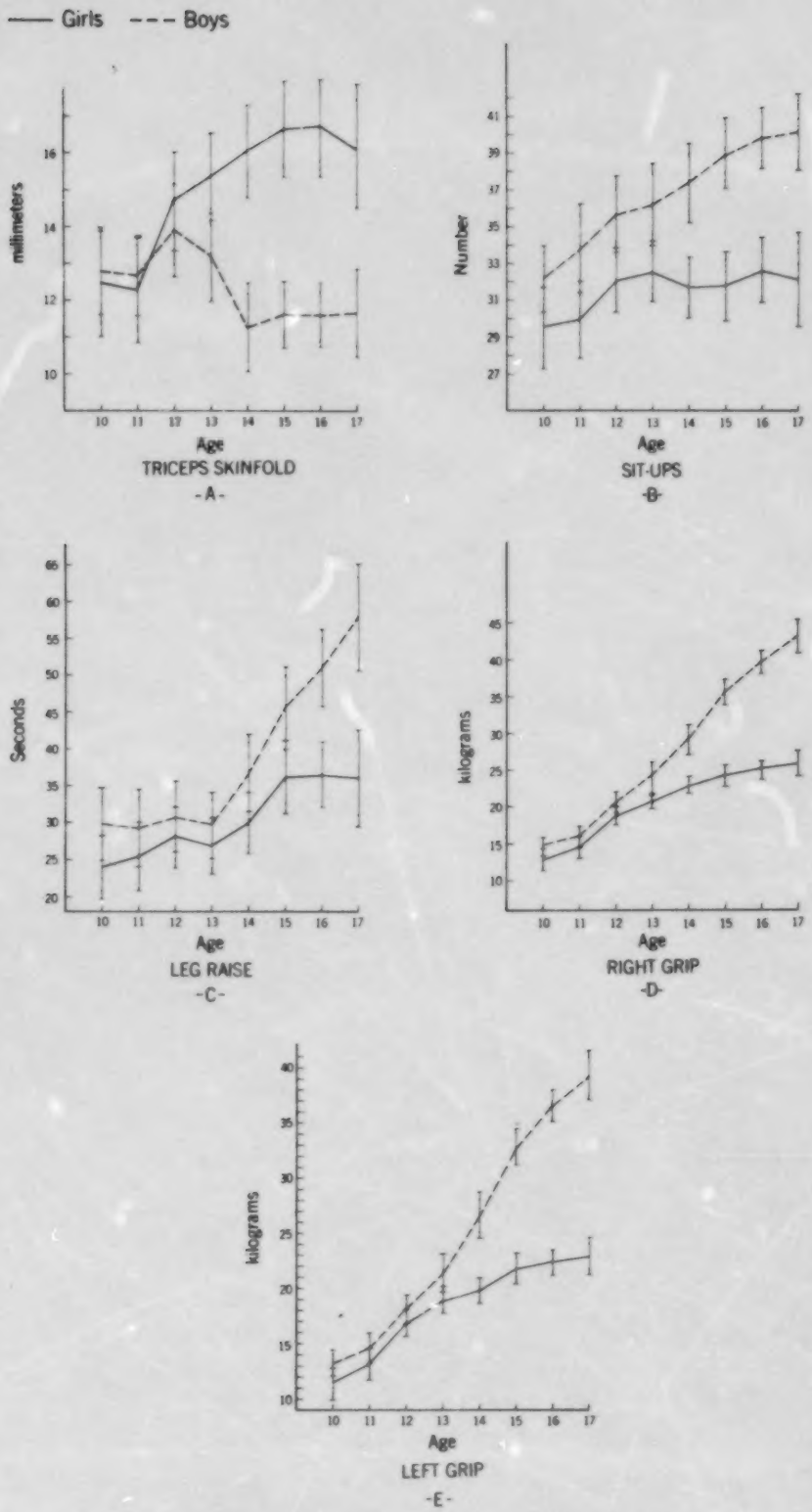

Figure 3.1 Significant sex by age interactions (means plotted with 99% confidence intervals) for normal, auditory impaired and visually impaired subjects.

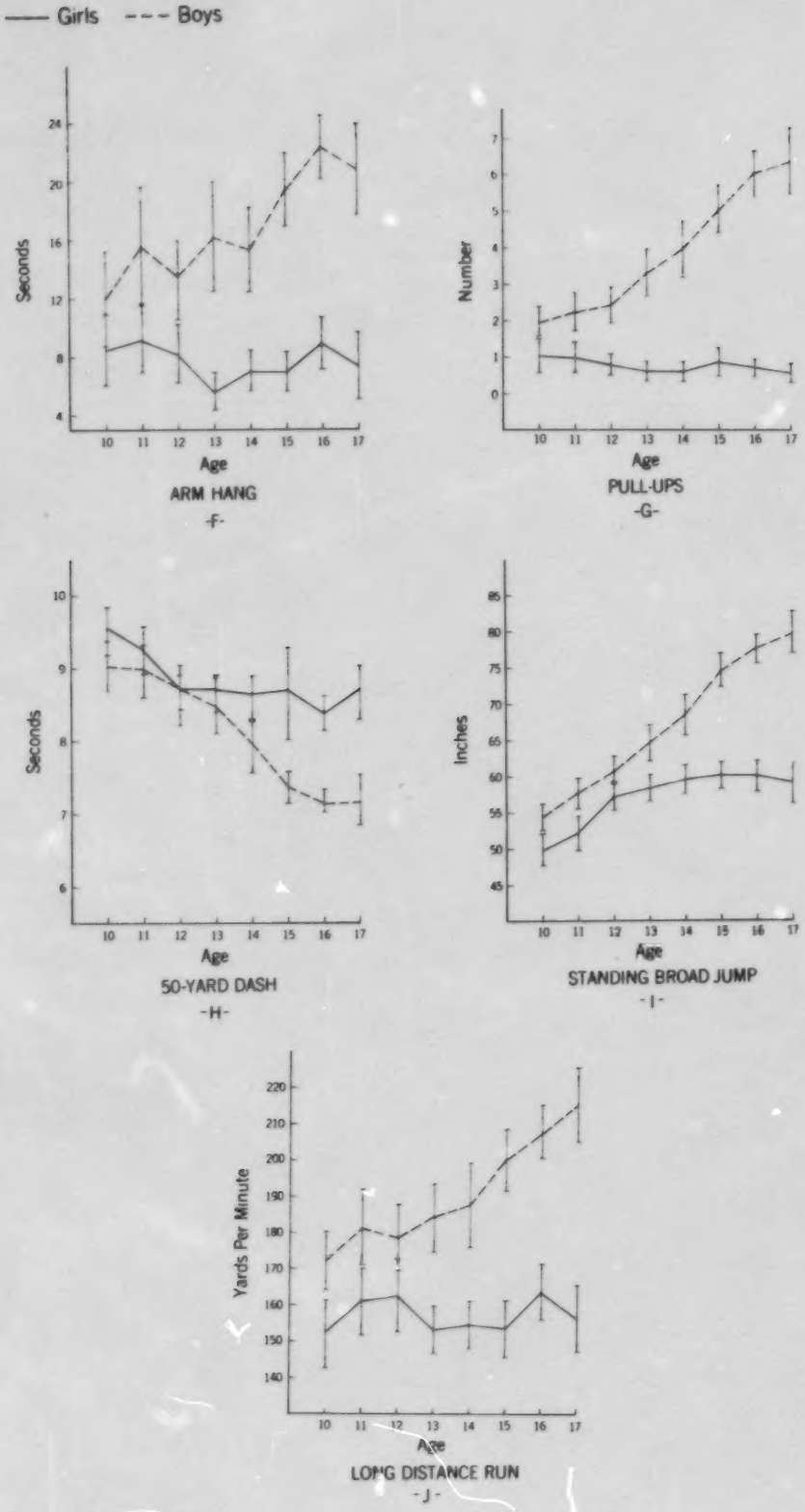

Figure 3 1 (cont) Significant sex by age interactions (means plotted with 99% confidence intervals) for normal, auditory impaired and visually impaired subjects.

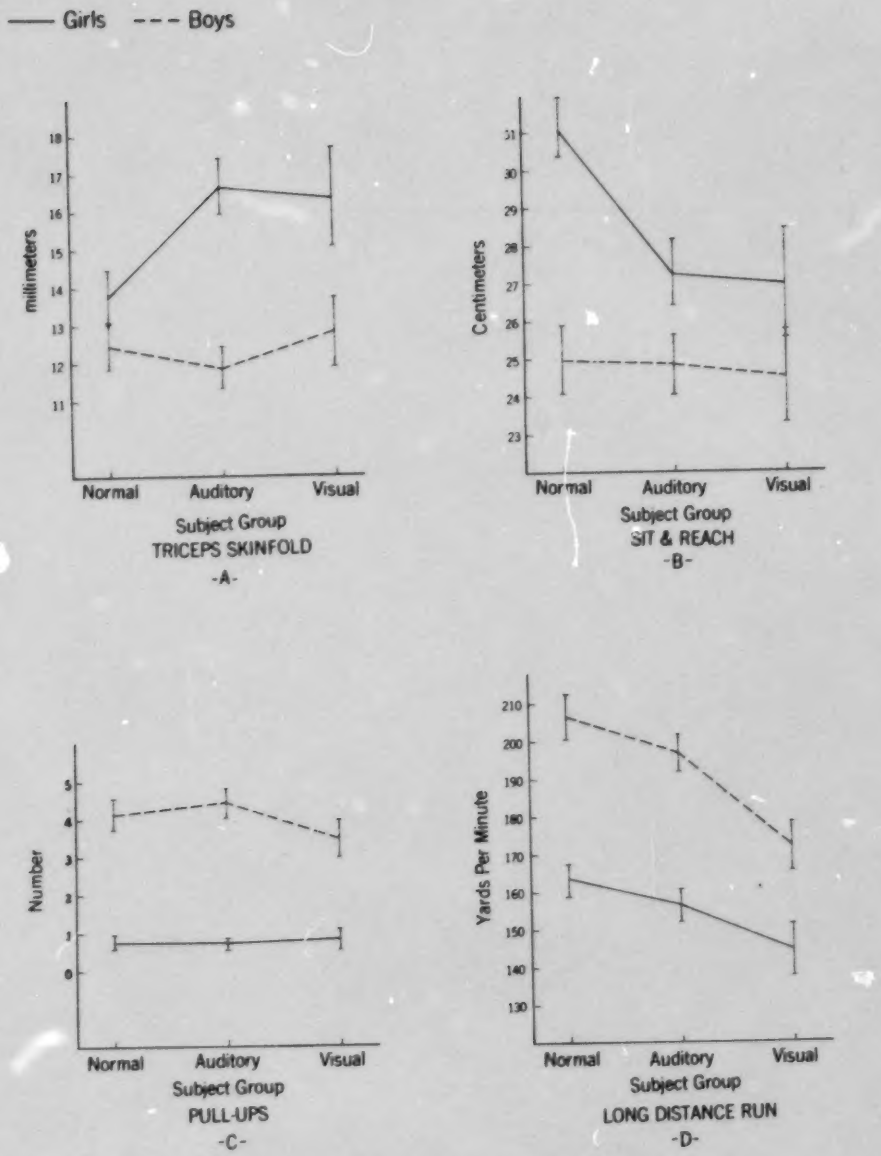

Figure 3.2 Significant sex by condition interactions (means plotted with 99% confidence intervals) for normal, auditory impaired and visually impaired subjects.

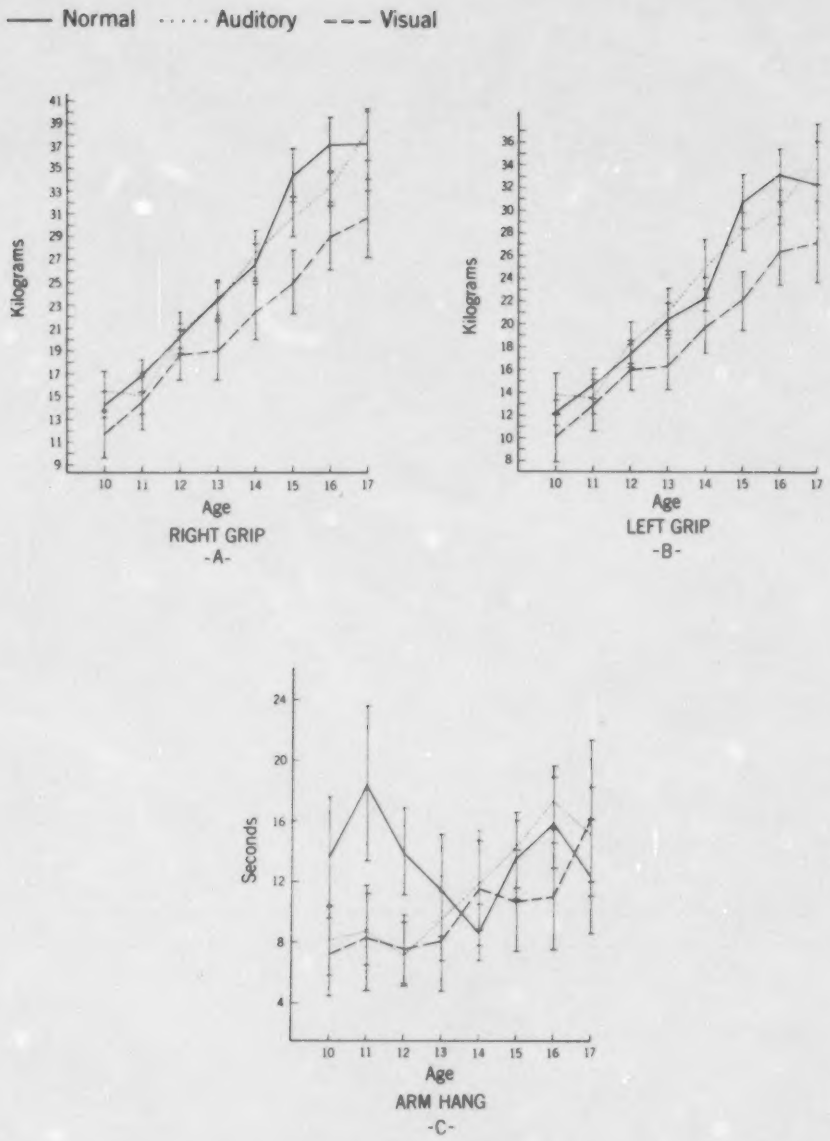

Figure 3.3 Significant age by condition interactions (means plotted with 99% confidence intervals) for normal, auditory impaired and visually impaired subjects.

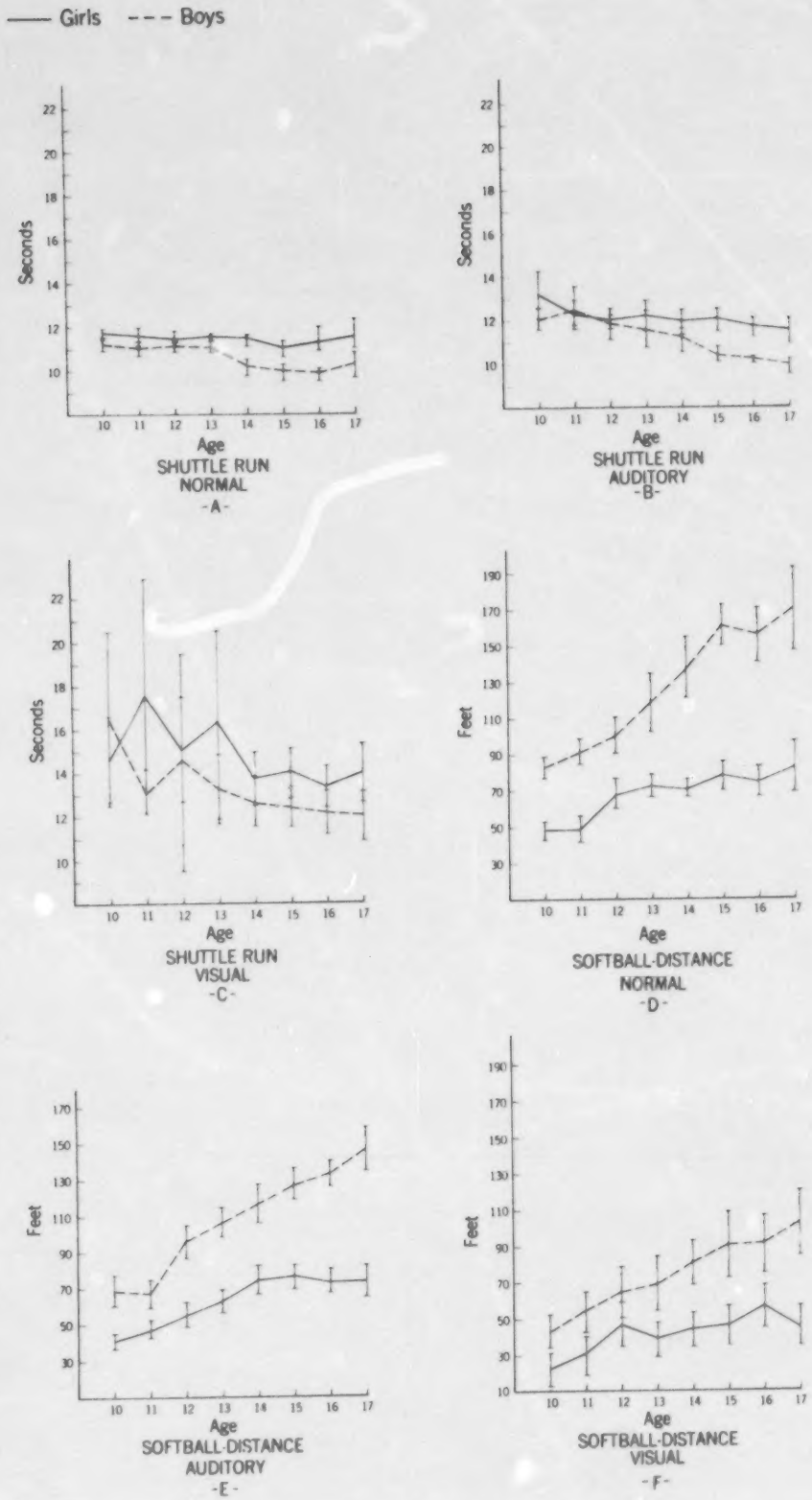

Figure 3.4 Significant sex by age by condition interactions (mean means plotted with 99% confidence intervals) for normal, auditory impaired and visually impaired subjects.

or 11 year old girls. Conversely, boys between the ages of 14 and 16 had significantly smaller skinfolds than 12 year old boys.

Abdominal Skinfold

Only main effects were significant for the abdominal skinfold measure. Girls had significantly larger skinfolds than boys. Subjects between the ages of 13 and 17 had significantly larger skinfolds than 10 and 11 year old subjects. Normal subjects (both boys and girls) had significantly smaller abdominal skinfolds than the visually impaired and auditory impaired subjects. No significant difference was found between auditory impaired and visually impaired subjects.

Subscapular Skinfold

Only main effects were significant for the subscapular skinfold measure. Girls had significantly larger skinfold measures than boys. Older subjects (13-17) had significantly larger skinfolds than younger subjects (10-11). Normal subjects had significantly smaller subscapular skinfolds than auditory impaired subjects and visually impaired subjects. No significant difference was found between auditory impaired and visually impaired subjects.

Sit-Ups

Results pertaining to sit-up performance (see Figure 3.1B) indicate that boys performed significantly more sit-ups than girls between ages 14 and 17. In view of the lack of significant interaction of condition with sex or age, the pattern can be considered similar for all three groups. Age was a significant factor for boys but not for girls. Older boys, in general, performed significantly more sit-ups than younger boys. Regardless of sex or age, normal subjects performed more sit-ups than the auditory impaired or the visually impaired groups. The auditory impaired and visually impaired groups did not differ significantly form each other on the sit-up test.

Leg Raise

Except for significant differences in favor of boys at the ages of 16 and 17, no significant differences were found on the leg raise test between boys and girls (see Figure 3.1C). Since condition does not interact significantly with sex or age, this pattern can be considered similar for all three groups. Age was a significant factor for both sexes; older subjects tended to perform longer leg raises than younger subjects, especially after age 13. There was no significant interaction of age and condition. Regardless of sex and age, normal subjects had significantly higher leg raise scores than auditory impaired or visually impaired subjects. No significant difference was observed between auditory impaired and visually impaired subjects.

Trunk Raise

Only the main effects of age and condition were significant for the univariate ANOVA on trunk raise. Regardless of condition or age, no significant difference in trunk raise performance was observed between boys and girls. The significant age effect was primarily due to the superior performance of the 16 year olds when contrasted to some of the younger age groups (10, 12, and 13); other differences in age were nonsignificant. Normal subjects performed

significantly longer trunk raises than both visually impaired and auditory impaired subjects, and auditory impaired subjects performed significantly longer trunk raises than visually impaired subjects.

Mat Creep

The main effects of sex, age, and condition were significant for the mat creep test. Boys were faster than girls on the mat creep. The lack of a significant sex by condition interaction indicates that this pattern can be considered similar for the three major groups. Despite the significant age effect, the Scheffe' procedure did not find any age differences at the .05 level. (When the Scheffe' alpha was raised to .10, a significant difference was found between 12 and 16-year old subjects favoring the older group.) Visually impaired subjects were significantly slower than normal and auditory impaired subjects. This difference, at least in part, may be attributable to the sight requirements of the task. There was no significant difference between normal and auditory impaired subjects on the mat creep.

Shuttle Run

Information pertaining to the shuttle run is presented in Figures 3.4A-C. A significant sex effect (boys faster than girls) was obtained for normal subjects between ages 14 and 17 and auditory impaired subjects between the ages of 15 and 17. No significant sex differences emerged for visually impaired subjects. Age was a significant factor for normal and auditory impaired boys; older boys tended to perform the shuttle run faster than younger boys. Age was not significant for normal and auditory impaired girls or for visually impaired boys and girls. Significant differences were observed between conditions for female subjects. Normal girls were faster than auditory impaired girls at 10 and 15 years of age, and were faster than visually impaired girls at all ages. Auditory impaired girls were faster than visually impaired girls at age 12 and between the ages of 14 and 17. Normal boys exceeded the performance of auditory impaired boys at 11 and 14 years of age and exceeded the performance of visually impaired boys at all ages except 12 and 17. Auditory impaired boys ran faster shuttle runs than visually impaired boys between ages 15 and 17. As with the mat creep, at least some of the differences observed between visually impaired subjects and those from the other two groups were probably the result of the sight requirements of the task and the fact that running procedures were modified (partner or guide wire assisted) for some visually impaired subjects. (In this regard, the reader may wish to interpret these results with some caution, since modifications in running procedure resulted in variances which were considerably larger for the visually impaired group than for either the normal or auditory impaired groups.) The effects of running procedures on the shuttle run performance of visually impaired participants is investigated in a subsequent section of this report.

Sit and Reach

Age was a significant factor on the sit and reach test regardless of sex or condition, with older subjects generally scoring significantly higher than younger subjects. Girls had significantly higher scores than boys on the sit and reach within the normal and auditory impaired groups. Sex was not a statistically significant factor for the visually impaired group (see Figure 3.2B). Condition was not a significant factor for boys; no significant

differences were observed between the three groups of subjects. Normal girl subjects, however, made significantly higher scores than auditory impaired or visually impaired girls. No significant differences were found between auditory impaired and visually impaired girls.

Right Grip Strength

Boys had significantly higher right hand grip strength scores than girls between ages 14 and 17. Age was a significant factor for all conditions; older subjects generally did better than younger subjects, and this was true of girls as well as boys. The sex by age interaction is apparently due to the fact that at approximately age 14, the rate of improvement was considerably greater for boys than it was for girls (see Figure 3.1D). No significant differences between normal and auditory impaired subjects on right hand grip strength were discovered. Normal subjects, however, made significantly higher scores than visually impaired subjects between the ages of 13 and 16. Auditory impaired subjects (boys and girls) exceeded the performance of the visually impaired subjects at ages 14, 15, and 17 (see Figure 3.3A).

Left Grip Strength

As with the right hand grip strength, boys made significantly higher scores than girls between the ages of 14 and 17 on left hand grip strength. This pattern may be considered similar for all groups. Age was a significant factor, regardless of sex or condition; although at approximately age 13, boys began to make more rapid gains in grip strength than did girls (see Figure 3.1E). No significant differences existed between normal and auditory impaired subjects. Normal subjects, however, significantly exceeded the performance of visually impaired subjects at ages 13, 15, and 16; and auditory impaired subjects surpassed visually impaired subjects at ages 10, 13, 14, 15, and 17 (see Figure 3.3B).

Flexed Arm Hang

The performance of boys on the arm hang significantly exceeded that of girls between the ages of 12 and 17 (see Figure 3.1F). Age was found to be a significant factor for boys, most notably due to the superior performance of the 15 to 17-year olds; no significant differences were observed between 10 to 14-year old boys. Age had a different effect for girls. A nonsignificant decrease in performance was found between 11 and 13-year old girls, followed by a significant increase between 13 and 16-year old girls. The age by condition interaction indicates that the performance curve for normal subjects is different than those of the two impaired groups (see Figure 3.3C). Age was significant for normals because of the inferior performance of the 14-year olds as opposed to the superior performance of the older groups (15-17), as is the case with the auditory and visually impaired subjects. Normal subjects did significantly better than visually impaired subjects between the ages of 10 and 12 and significantly better than auditory impaired subjects at ages 11 and 12. Auditory impaired subjects made significantly higher scores than visually impaired subjects at age 16, but no other significant condition differences were observed.

Pull-Ups

Regardless of age or condition, boys did significantly more pull-ups than girls (see Figures 3.1G and 3.2C). Age was a significant factor for boys;

performance increased as age increased. Age was a nonsignificant factor for girls; in fact, performance even declined somewhat between ages 11 and 14 and 15 and 17. Condition was not a significant factor for girls; no significant differences were observed between the subject groups for girls. Auditory impaired boys, however, made significantly higher scores than visually impaired boys on pull-ups. The performance of the normal boys did not differ significantly from the performance of either of the impaired groups.

50-Yard Dash

Results of data analysis indicate that boys significantly exceeded the performance of girls on the 50-yard dash for all conditions. Boys ran significantly faster than girls between the ages of 15 and 17 (see Figure 3.1H). Age was a significant factor for both sexes, although boys demonstrated steady improvement between ages 13 and 16, and girls demonstrated no significant improvement after age 12. No significant difference was observed between normal and auditory impaired subjects, although visually impaired subjects were significantly slower than normal or auditory impaired subjects on the 50-yard dash. At least part of this difference would seem to be attributable to the sight requirements of the task and the different running procedures (guide wire or partner assisted) employed by some visually impaired runners. (As with the shuttle run, the reader may wish to interpret these results with some caution, since modifications in running procedure resulted in variances which were larger for the visually impaired group than for either the normal or auditory impaired groups.) The effects of running procedure on the 50-yard dash performance of visually impaired participants is investigated in a subsequent section of this report.

Standing Broad Jump

With the exception of age 12, the performance of boys significantly exceeded that of girls on the standing broad jump (see Figure 3.1I). Since condition did not interact significantly with either sex or age, this pattern is considered similar for all groups. Age was a significant factor for both sexes, although boys made steady improvement to age 17, and girls made no significant improvement after age 12. No significant differences existed between normal and auditory impaired subjects; however, normal and auditory impaired subjects jumped a significantly longer distance than visually impaired subjects on the standing broad jump.

Softball Throw (Distance)

Boys were found to throw the softball a significantly greater distance than girls across all ages and all conditions except for 12-year old visually impaired subjects where no sex difference was found (see Figures 3.4D-F). Age was a significant factor for both sexes and all conditions; older subjects generally threw the ball farther than younger subjects. The rate of improvement over age, however, seemed to be greater for boys, especially for normal and auditory impaired boys. No significant differences were found between normal and auditory impaired girls on the softball throw. Normal girls, regardless of age, threw significantly farther than visually impaired girls; and with two exceptions (ages 12 and 16), auditory impaired girls also threw significantly farther than visually impaired girls. Normal boys threw farther than auditory impaired boys at 10, 11, 15, and 16 years of age and significantly farther than

visually impaired boys at all ages. Auditory impaired boys outdistanced visually impaired boys at all ages with the exception of age 11, where no significant difference was detected.

Long Distance Run

Boys made significantly superior long distance run scores than girls regardless of condition or, with one exception (age 12), age. Age was a significant factor for boys (older boys tended to accumulate more yards per minute than younger boys), but it was not a significant factor for girls (see Figure 3.1J). Regardless of sex, the difference between normal and auditory impaired subjects was not significant at the .01 level. The long distance run scores of normal and auditory impaired subjects, however, were significantly higher than those of the visually impaired subjects (see Figure 3.2D). Some of the differences observed between visually impaired subjects and those of the other groups are probably attributable to different running procedures (running with the aid of a partner or guide wire) employed by some visually impaired subjects. The effects of running procedures on the long distance run performance of visually impaired participants are investigated in a subsequent section of this document.

Summary

In this section, the effects of sex, age, and condition on physical fitness performance are presented. With two exceptions, the performance of boys was significantly superior to the performance of girls on the test items. No sex difference was found on the timed trunk raise item, and girls were found to be significantly superior to boys on the sit and reach test. The fact that girls exceeded the performance of boys on a measure of flexibility is consistent with previous research findings. The trunk raise finding, however, is of more interest. Subjects who took the trunk raise were instructed to fully hyperextend the back and hold the position for as long as possible. Perhaps the girls were able to hyperextend their backs to a greater extent than boys and, in so doing, obtained a mechanical advantage which allowed the girls to maintain the trunk raise for a period of time commensurate with the boys. Therefore, the strong performance of the girls on the trunk raise may have been due as much to low back flexibility as to the strength of the back extensors. In addition to the performance items, girls were found to have significantly larger skinfold measures taken from the triceps, abdominal, and subscapular regions than boys (differences between normal boys and girls on the triceps measure was significant at the .05 level but not at the .01 level).

Generally speaking, age was found to be a significant factor on performance and skinfold measures. Sex, however, was found to have a differential effect on age on four test items. For the sit-ups, pull-ups, and long distance run, age was found to be a significant factor for boys, but not for girls. On the triceps skinfold measure, older girls tended to have larger skinfolds, while older boys tended to have smaller skinfolds than their younger counterparts. Overall, performance tended to improve with age, and skinfold measures (with the exception noted above) tended to increase with age.

Although the extent of differences vary from item to item, the performance of normal subjects was never exceeded significantly by the performance of

either the auditory impaired or visually impaired groups. For a number of test items, no significant differences were found between normal and auditory impaired subjects: standing broad jump, 50-yard dash, mat creep, right and left grip strength, long distance run, pull-ups, triceps skinfold (boys), sit and reach (boys), and softball throw (girls). Significant differences were found for at least one age for abdominal skinfold, subscapular skinfold, sit-ups, leg raise, trunk raise, shuttle run, arm hang, triceps skinfold (girls), sit and reach (girls), and softball throw for distance (boys). No significant differences were found between normal and visually impaired subjects on pull-ups, triceps skinfold (boys), and sit and reach (boys). Significant differences between normal and visually impaired subjects, on at least one age, were found in the following test items: abdominal skinfold, subscapular skinfold, sit-ups, leg raise, trunk raise, mat creep, shuttle run, right and left grip strength, flexed arm hang, 50-yard dash, softball throw for distance, standing broad jump, long distance run, triceps skinfold (girls), and sit and reach (girls). In regard to comparisons between auditory impaired and visually impaired subjects, no significant differences were found on the following test items: triceps skinfold, abdominal skinfold, subscapular skinfold, sit-ups, leg raise, sit and reach, and pull-ups (girls). Significant differences between auditory impaired and visually impaired subjects were found on at least one age on the following items: trunk raise, mat creep, shuttle run, right grip, left grip, flexed arm hang, 50-yard dash, standing broad jump, softball distance, long distance run, and pull-ups (boys).

Based on the information presented above, it is clear that the performance of normal subjects generally exceeds that of the other two groups. It is also clear that the performance of auditory impaired subjects generally exceeds that of children and youth with visual impairments. Certainly, differences favoring the normal and auditory impaired over the visually impaired would be expected in running items such as the 50-yard dash, shuttle run, and long distance run because of the effect of sight on performance. However, differences in grip strength, arm hang, pull-ups, and standing broad jump would be less expected.

Normal and Cerebral Palsy Comparisons

As in the previous analysis, a three-way univariate ANOVA classified by sex, age, and condition was used to compare normal and cerebral palsied subjects on those items where procedures were reasonably similar. Comparisons with normal subjects were not made on the mat creep, shuttle run, 50-yard dash, softball throw, or long distance run due to procedural differences. Each of these five items was analyzed for sex and age differences within the cerebral palsy group, and these results are subsequently presented in this chapter.

Cerebral palsied subjects were entered into each analysis based upon the cerebral palsy participation guide (see page 72). As mentioned earlier, this approach obviated a multivariate ANOVA procedure. The results of the three-way univariate ANOVA are presented in Table 3.11.

The results of the univariate ANOVAs are discussed below for each test item.

Triceps

Sex was a significant factor for cerebral palsied subjects; girls had significantly larger skinfold measures than boys. As noted earlier, the

TABLE 3.11. UNIVARIATE F VALUES FOR NORMAL AND CEREBRAL PALSIED SUBJECTS BY SEX, AGE, AND CONDITION.

Test Item	Sex	Age	Cond.	Sex X Age	Sex X Cond.	Age X Cond.	Sex X Age X Cond.
Triceps Skinfold	23.87*	3.27*	.09	4.01*	7.27*	.71	1.65
Abdominal Skinfold	14.05*	6.91*	.63	2.13	.18	1.41	.78
Subscapular Skinfold	5.76	7.44*	3.38	.73	1.23	.90	1.39
Sit-Ups	59.52*	1.07	2410.77*	3.26*	13.53*	6.80*	.11
Leg Raise	9.95*	3.96*	288.44*	.95	5.25	3.15*	.65
Trunk Raise	.86	.62	93.79*	.59	.01	1.19	.73
Sit and Reach	28.09*	3.72*	191.74*	1.95	10.21*	3.25*	1.75
Right Grip	155.37*	95.52*	720.18*	10.79*	30.68*	12.21*	1.77
Left Grip	158.12*	80.47*	460.43*	10.98*	19.75*	9.46*	2.78*
Arm Hang	44.28*	1.06	100.93*	.89	10.93*	.90	.40
Pull-Ups	143.39*	3.61*	82.51*	6.40*	42.83*	1.19	1.33
Broad Jump	81.90*	9.83*	1235.00*	4.14*	3.27	4.43*	1.66

*Significant at the .01 level.

difference between normal girls and normal boys was not significant at the .01 level (see Figure 3.6A). The significant sex by age interaction (see Figure 3.5A) was due to the fact that boys had significantly smaller skinfolds than girls at ages 14 and 16, but no other sex by age differences were noted. Presumably, the sex differences at 14 and 16 years may be attributed more to the cerebral palsied group since the sex effect for normals was nonsignificant. Regardless of condition, age was a significant factor for both boys and girls, but apparently for different reasons. Fourteen-year old girls had significantly larger skinfolds than 11-year old girls, while 16-year old boys had significantly smaller skinfolds than 12-year old boys. Where differences were significant, therefore, older girls had larger measures and older boys smaller measures than their younger counterparts. Condition was not a significant factor on the triceps skinfold; no significant differences existed between normal and cerebral palsied boys or between normal and cerebral palsied girls.

Abdominal Skinfold

Only the main effects of sex and age were found to be significant for the abdominal skinfold. Regardless of age or condition, girls had significantly larger skinfolds than boys. The significant age effect was due primarily to differences in 10 and 11-year olds when contrasted with some of the older age groups (most notably 13, 14, and 15-year olds). The 10 and 11-year olds had significantly smaller abdominal skinfolds than some of the older groups. In one instance, however, a younger age group (14) was found to have a significantly larger skinfold than an older age group (16). Condition was not a significant factor for this test item.

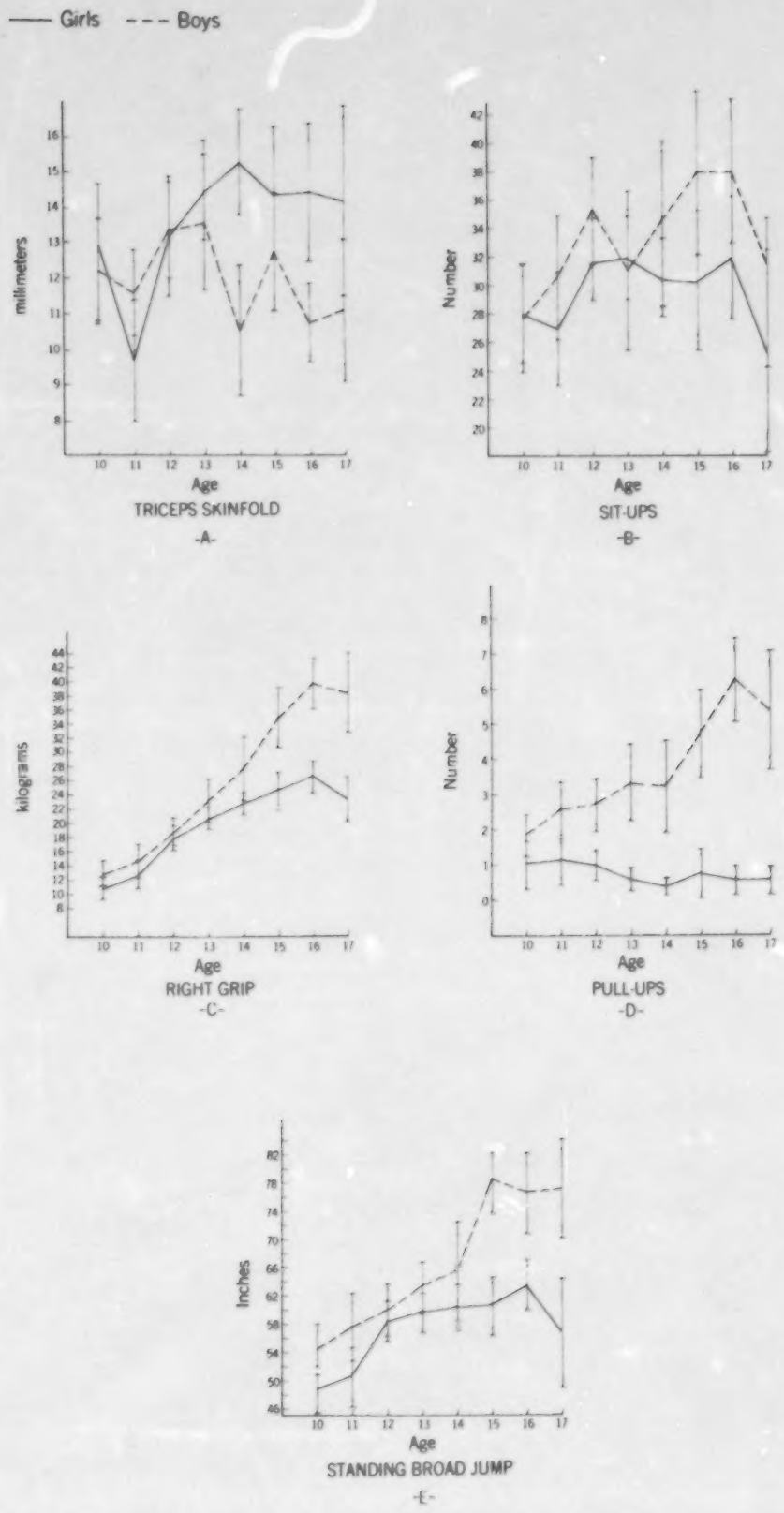

Figure 3.5 Significant sex by age interactions (means plotted with 99% confidence intervals) for normal and cerebral palsied subjects.

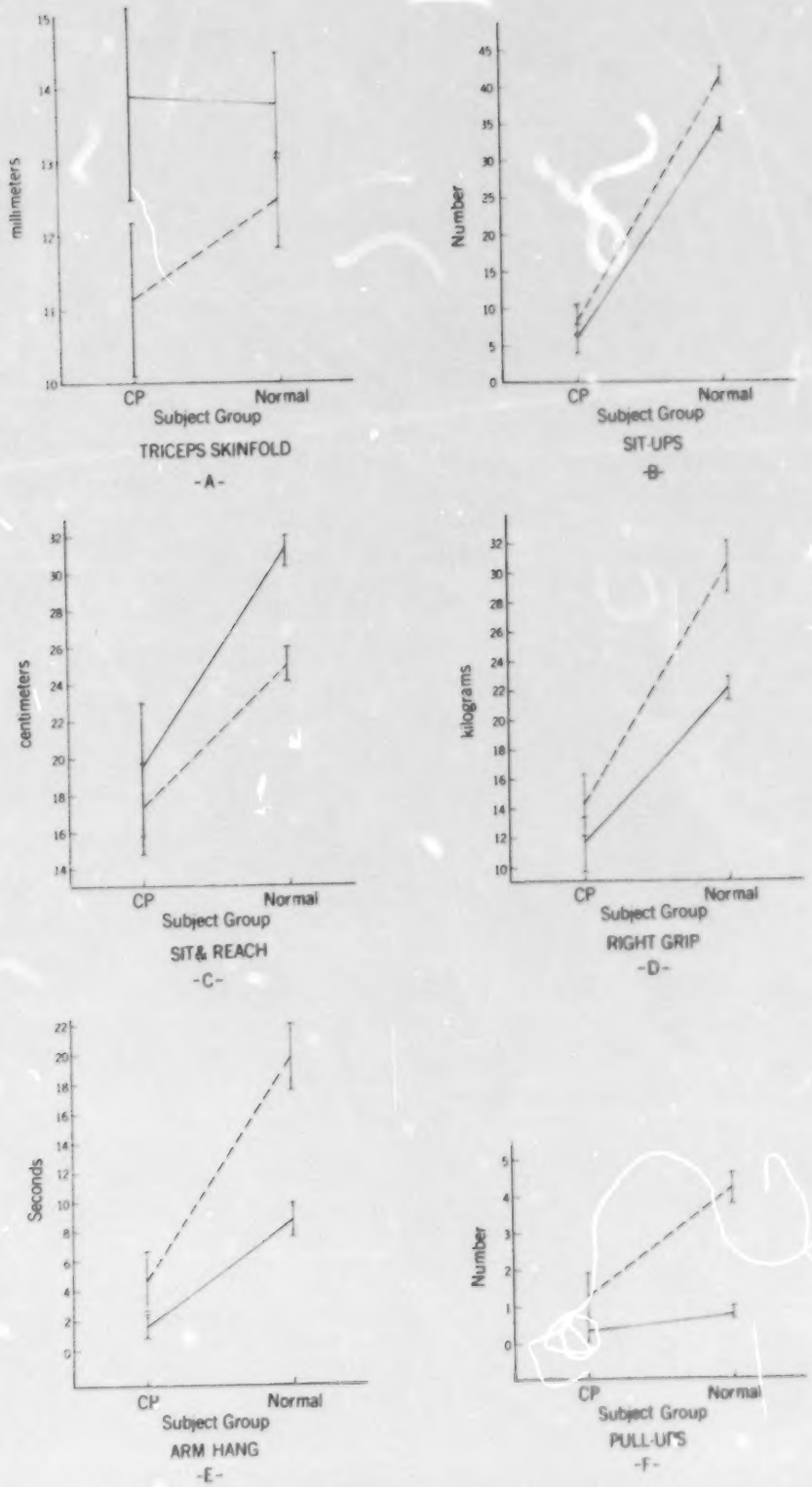

Figure 3.6 Significant sex by condition interactions (means plotted with 99% confidence intervals) for normal and cerebral palsied subjects.

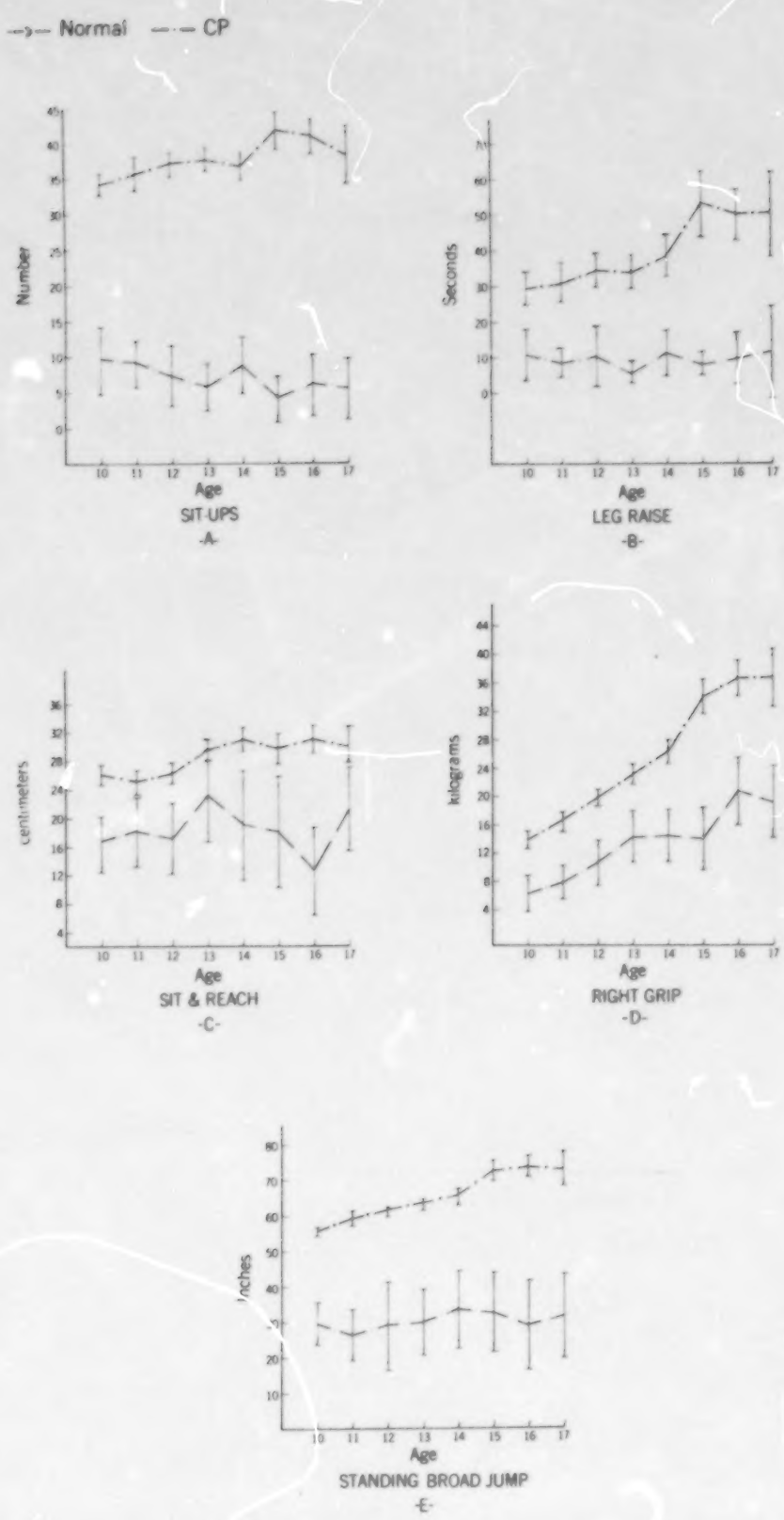

Figure 3.7 Significant age by condition interactions (means plotted with 99% confidence intervals) for normal and cerebral palsied subjects.

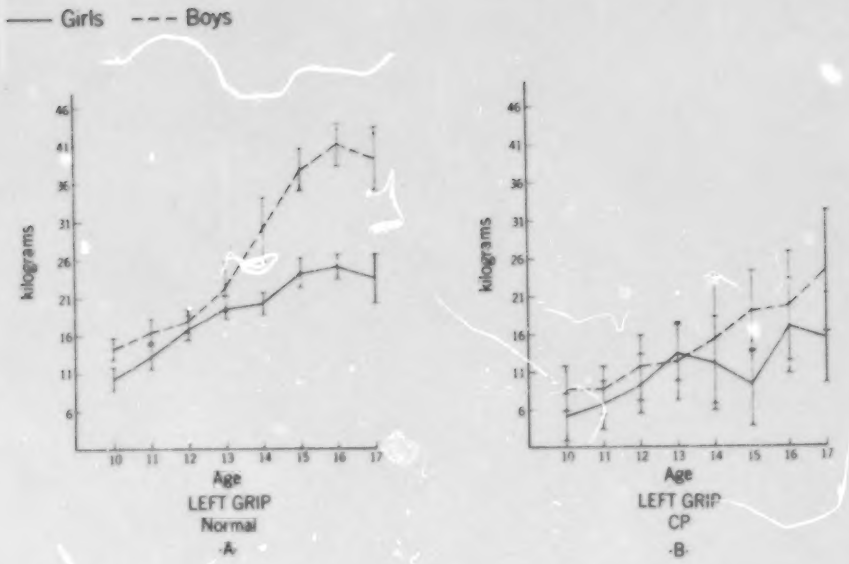

Figure 3.8 Significant sex by age by condition interactions (means plotted with 99% confidence intervals) for normal and cerebral palsied subjects.

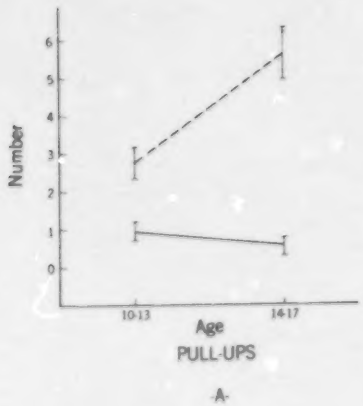

Figure 3.9 Significant sex by age interactions (means plotted with 99% confidence intervals) for normal and spinal neuromuscular subjects.

Subscapular Skinfold

Age was the only significant factor which emerged on the subscapular skinfold; sex and condition were not significant factors. As with the abdominal skinfold, age differences in the subscapular skinfold were due primarily to differences of 10 and 11-year olds when compared to some of the older age groups (13, 14, 15, and 17). The 10 and 11-year old subjects had significantly smaller skinfolds than the older subjects.

Sit-Ups

Interpretation of the sit-up test was difficult because all three two-way interactions were significant in the absence of a three-way interaction (see Figures 3.5B, 3.6B, and 3.7A). Condition, however, was clearly a significant factor; regardless of sex or age, normal subjects performed more sit-ups than cerebral palsied subjects. Sex was apparently a significant factor for normals, but not for cerebral palsied subjects. Normal boys performed more sit-ups than normal girls. The graph depicting the sex by age interaction is not helpful, however, in identifying at which ages these differences exist; no significant sex by age differences were found when this interaction was plotted (see Figure 3.5B). (In the absence of a significant sex by age by condition effect, this conflict is not easily explained. Since sex was a significant factor for normal subjects but not for cerebral palsied subjects, an "averaging effect" may have obscured real sex differences for normal subjects at certain ages. The larger standard error of the mean for the normal and cerebral palsied combined group resulted in the generation of wider confidence intervals which may have served to mask true differences. When separate graphs for normal boys and girls and cerebral palsied boys and girls were plotted, significant differences between normal boys and girls existed between the ages of 14 and 17; however, no differences between cerebral palsied boys and girls were observed.) Age was a significant factor for boys (apparently more so for normal boys in light of the age by condition interaction), but not for girls. This was apparently due to the superior performance of the 15 and 16-year old boys when contrasted with 10-year old boys. Furthermore, age had a significant effect on normal subjects (older subjects tended to make higher scores), but no significant differences between age groups were detected for cerebral palsied subjects. In fact, a slight (but nonsignificant) tendency for scores to decline with age was noticed with the cerebral palsied group.

Leg Raise

Boys performed significantly longer leg raises than girls regardless of age or condition. Age was a significant factor for normal subjects (15 and 16-year olds had larger scores than 10 to 13-year olds), but not for cerebral palsied subjects (see Figure 3.7B). Regardless of sex or age, normal subjects performed significantly longer leg raises than cerebral palsied subjects.

Trunk Raise

The main effect of condition was the only significant factor which emerged from the trunk raise; no significant differences were found for sex or age. Regardless of sex or age, normal subjects performed significantly longer trunk raises than cerebral palsied subjects.

Sit and Reach

Normal girls, regardless of age, significantly exceeded the performance of normal boys on the sit and reach. Cerebral palsied girls made higher scores than cerebral palsied boys, but the difference was not statistically significant. Age was a significant factor for normal subjects; generally, older subjects made higher scores than younger subjects. Age was not a significant factor for cerebral palsied subjects. Regardless of sex, normal subjects were superior to cerebral palsied subjects on the sit and reach (see Figure 3.6C). With the exception of age 13 where no significant difference was observed, normals made significantly higher scores than cerebral palsied subjects at all ages (see Figure 3.7C).

Right Grip Strength

As with sit-ups, the emergence of three significant two-way interactions in the absence of a significant three-way interaction made the interpretation of the right hand grip strength somewhat more difficult (see Figures 3.5C, 3.6D, and 3.7D). Condition, however, was clearly a significant factor regardless of sex or age. Normal subjects exceeded the performance of cerebral palsied subjects. Normal boys made significantly higher scores than normal girls, but no such difference was observed for cerebral palsied subjects. The sex difference for normal subjects was operative at the upper ages. The sex by age graphic analysis (see Figure 3.5C) indicates that significant sex differences existed between ages 15 to 17. (In the previous section, it was reported that sex differences on the right grip for normal subjects occurred between 13 and 17 years. As with the sit-ups, perhaps the "averaging effect" of combining the normal and cerebral palsied groups served to obscure a true difference at ages 13 and 14 in the present analysis.) Age appeared to be a significant factor for both sexes and both subject groups; older subjects generally made higher scores than younger subjects.

Left Grip Strength

The sex by age by condition interaction was found to be significant for the left hand grip strength (see Figures 3.8A and 3.8B). Significant sex differences were observed between normal boys and girls at 10 years of age and between 14 and 17 years of age. No significant sex differences were found for the cerebral palsied group. Age was a significant factor for both normal and cerebral palsied subjects regardless of sex. Generally, older subjects made better scores than younger subjects, although the performance curves for cerebral palsied subjects (especially girls) were more erratic than those of the normal subjects. With one exception, normal subjects, regardless of sex or age, were found to have significantly higher left hand grip scores than cerebral palsied subjects. No significant difference was observed between 17-year old normal and cerebral palsied girls.

Flexed Arm Hang

Boys performed significantly longer flexed arm hangs than girls, regardless of age or condition. The sex by condition interaction is apparently due to the fact that there is a greater difference between the normal boys and girls, although the difference is significant in both cases (see Figure 3.6E).

Age was not a significant factor in this analysis regardless of sex or condition. Normal subjects made significantly higher scores on the arm hang than cerebral palsied subjects.

Pull-Ups

Normal boys executed a significantly greater number of pull-ups than normal girls. Boys significantly exceeded the performance of girls between the ages of 12 and 17. The difference between cerebral palsied boys and girls was not significant at the .01 level. Age was found to have a different effect on pull-up performance for boys and girls (see Figure 3.5D). Boys generally improved with age and significant differences emerged between the 10 to 12 and 15 to 17 age groups. No significant age difference was found for girls; in fact, there was a general decline in performance between the ages of 11 and 14. Normal boys did a significantly greater number of pull-ups than cerebral palsied boys; however, the difference between normal girls and cerebral palsied girls was not significant (see Figure 3.6F).

Standing Broad Jump

Boys, regardless of condition, jumped significantly farther than girls on the standing broad jump between the ages of 15 and 17 (see Figure 3.5E). (When normal subjects were analyzed with auditory and visually impaired subjects, significant sex differences were found at all ages, except age 12.) Age was a significant factor for normal subjects but not for cerebral palsied subjects (see Figure 3.7E). The performance of the normal subjects generally improved with age and age had a significant effect for both boys and girls. Regardless of sex or age, normal subjects jumped significantly farther than cerebral palsied subjects.

Additional Sex and Age Comparisons Within the Cerebral Palsied Group

The data presented below in Table 3.12 depict the effects of sex and age on the fitness test performance of subjects with cerebral palsy on mat creep, shuttle run, 50-yard dash, softball distance, and long distance run. Comparisons with normal subjects were not made on these items since procedures were modified significantly for some cerebral palsied participants.

TABLE 3.12. UNIVARIATE F VALUES FOR CEREBRAL PALSIED SUBJECTS BY SEX AND AGE.

Test Item	Sex	Age	Sex X Age
Mat Creep	3.66	1.73	.87
Shuttle Run	1.51	1.28	.94
50-Yard Dash	8.32*	2.17	1.50
Softball Distance	37.53*	.85	1.20
Long Distance Run	3.40	.88	.61

*Significant at the .01 level.

The data in Table 3.12 indicate that sex was a significant factor on two of the variables: 50-yard dash and softball throw. In both of these cases, performance differences favored the boys. No other sex or age differences were observed on these five items for subjects with cerebral palsy.

Summary

This section of the report analyzed sex, age, and condition differences for normal and cerebral palsied subjects. With the exception of the skinfold measures, the performance of girls on the pull-up test and the performance of 17-year old girls on left grip, significant differences favoring normal subjects were found on all test items. Far fewer sex and age differences were found in the cerebral palsied group than in the normal group. With the exception of the trunk raise, sex was a significant factor for normal subjects on all test items. With the exception of the sit and reach test, this difference favored normal boys. In regard to skinfolds, there was no significant difference between normal boys and girls, but normal girls had significantly higher abdominal and subscapular skinfolds than normal boys. For the cerebral palsied group, sex was a significant factor on the triceps and abdominal skinfolds, leg raise, flexed arm hang, standing broad jump, 50-yard dash, and softball throw. Age was found to be significant for cerebral palsied subjects on only three performance items, the two grip strength measures, pull-ups (boys only), and the skinfold tests. Conversely, age was a significant factor for normal subjects on virtually all test items. (Trunk raise and flexed arm hang did not yield significant age effects for normals in this analysis; however, age was found to be significant for both when the performance of normal subjects was analyzed with the performance of auditory impaired and visually impaired subjects.)

The findings presented here should probably be viewed with a certain degree of caution, especially those findings drawn from graphs depicting sex by age interactions. In these graphs, normal and cerebral palsied subjects were combined and performance was plotted by sex and age. When normal and cerebral palsied subjects were combined, however, the large discrepancy in mean scores generally resulted in the computation of a standard deviation which was larger in the combined group than it was in either of the separate groups. This larger standard deviation, in turn, contributed to a relatively large standard error of the mean which eventually resulted in the generation of very wide confidence intervals. The width of these intervals probably served to obscure some true significant sex by age differences.

Normal and Spinal Neuromuscular Comparisons

A three-way ANOVA design was used to investigate sex, age, and condition differences between normal subjects and subjects with spinal neuromuscular conditions on those items where procedures were reasonably similar (skinfolds, grip strength, arm hang, and pull-ups). Comparisons between subject groups were not made on shuttle run, 50-yard dash, long distance run, or softball throw due to significant procedural differences. The effects of sex and age on the performance of spinal neuromuscular participants were investigated separately for these items, and these results are presented later in this section.

Quadriplegic spinal neuromuscular subjects were not included in this analysis due to the low number of subjects in the category (N=6) and the fact that quadriplegic participants were subject to a different schedule of items than paraplegic participants (see participation guide, page 81). All other subjects with spinal neuromuscular conditions were included in this analysis (N=141, boys = 72, girls = 69). Due to the relatively low number of subjects in the spinal neuromuscular group, the age variable was reduced to two groups for this analysis: 10 to 13 years of age (SN boys = 39, SN girls = 45) and 14 to 17 years of age (SN boys = 33, SN girls = 24).

The results of the multivariate ANOVA indicated that all three two-way interactions were significant ($p < .002$) for this analysis. Since the multivariate ANOVA indicated the presence of an "interaction model," the univariate analysis was performed post hoc. The results of the three-way univariate ANOVA are presented in Table 3.13.

TABLE 3.13. UNIVARIATE F VALUES FOR NORMAL AND SPINAL NEUROMUSCULAR SUBJECTS BY SEX, AGE, AND CONDITION.

Test Item	Sex	Age	Cond.	Sex X Age	Sex X Cond.	Age X Cond.	Sex X Age X Cond.
Triceps Skinfold	8.69*	4.57	25.82*	31.19*	.22	3.38	8.91*
Abdominal Skinfold	5.13	14.12*	35.72*	5.23	.99	5.17	2.81
Subscapular Skinfold	1.52	23.89*	54.00*	8.69*	.41	6.28	10.71*
Right Grip	132.92*	284.01*	75.69*	31.62*	.00	6.93*	11.26*
Left Grip	116.05*	248.74*	56.75*	33.78*	.35	5.51	13.62*
Arm Hang	25.95*	.05	43.17*	.63	7.15*	.51	.31
Pull-Ups	104.22*	14.47*	17.38*	37.63*	19.43*	2.20	.30

*Significant at the .01 level.

The results of the univariate analysis are discussed below for each test item.

Triceps Skinfold

A significant sex by age by condition effect emerged on the triceps skinfold (see Figures 3.11A and 3.11B). Sex was a significant factor for older (14-17) normal subjects; girls had larger skinfolds than boys. Sex was not a significant factor for younger (10-13) normal subjects or for spinal neuromuscular subjects at either age group. Age was not significant for normal subjects or for spinal neuromuscular boys, but older spinal neuromuscular girls had significantly larger skinfolds than younger spinal neuromuscular girls. Older spinal neuromuscular girls had significantly larger skinfolds than older normal girls, but no other condition effects were significant.

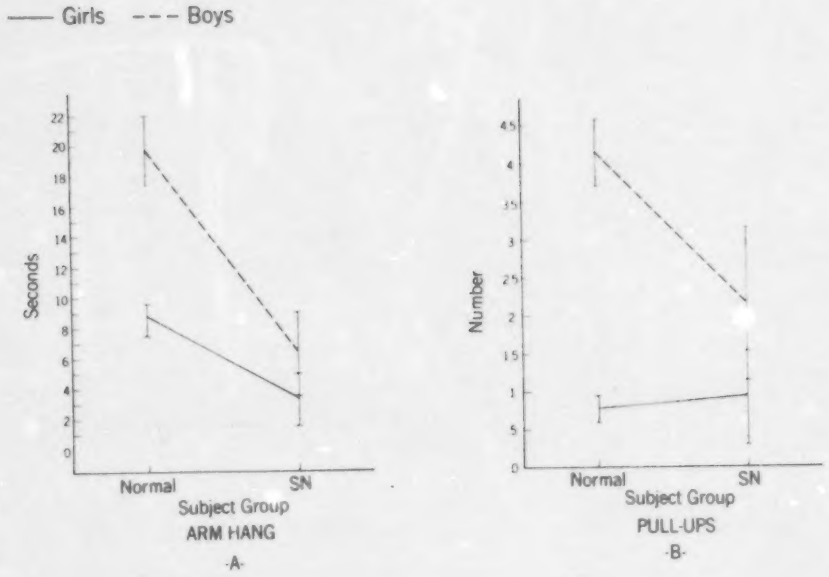

Figure 3.10 Significant sex by condition interactions (means plotted with 99% confidence intervals) for normal and spinal neuromuscular subjects.

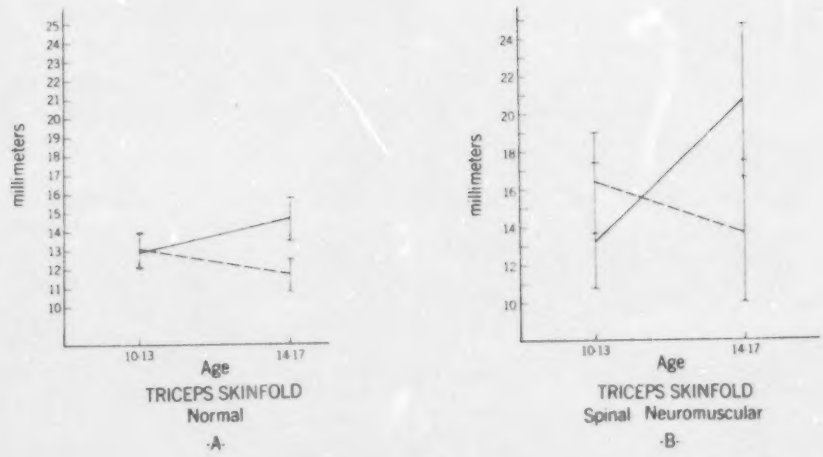

Figure 3.11 Significant sex by age by condition interactions (means plotted with 99% confidence intervals) for normal and spinal neuromuscular subjects.

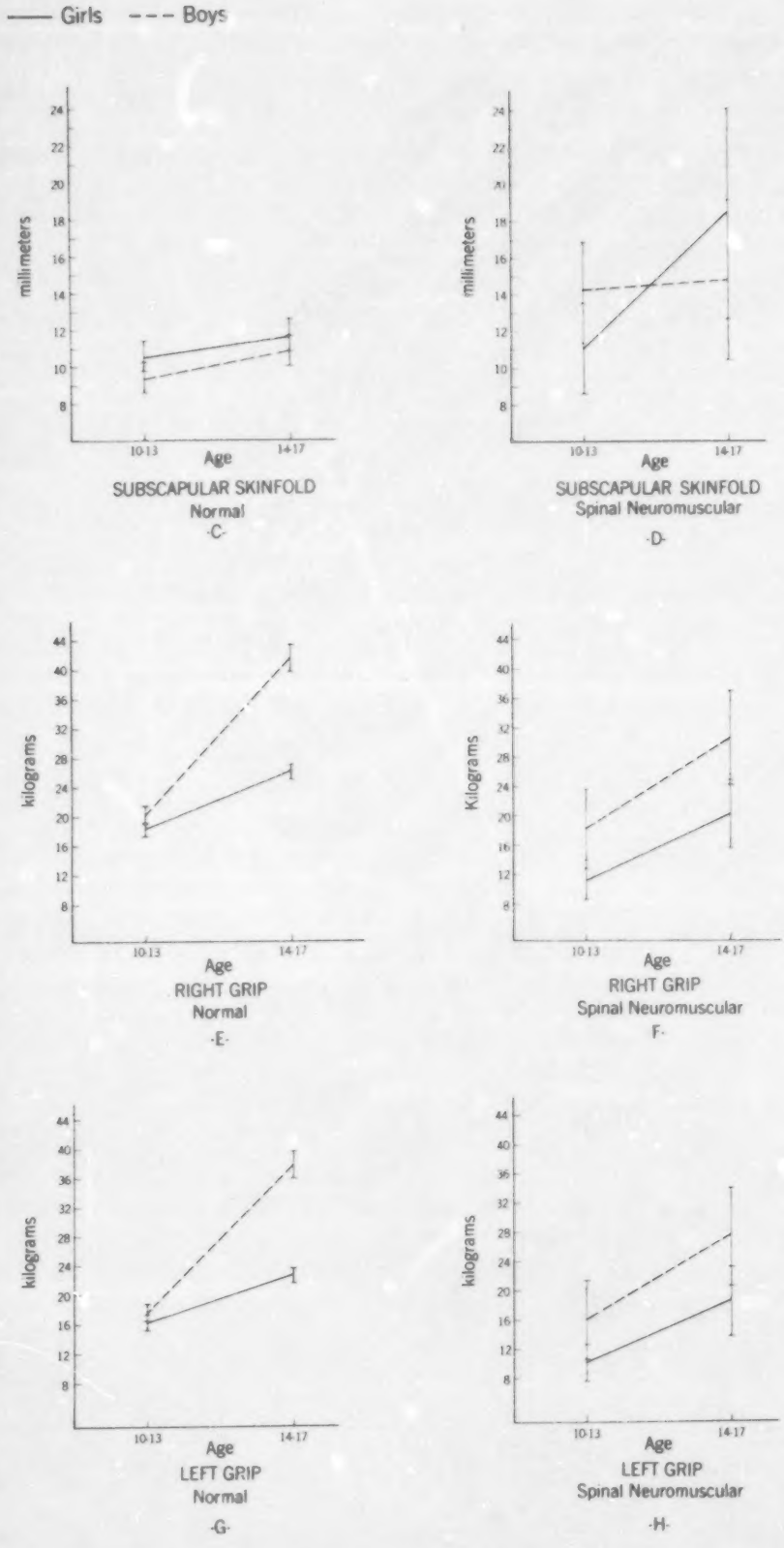

Figure 3.11 (cont.) Significant sex by age by condition interactions (means plotted with 99% confidence intervals) for normal and spinal neuromuscular subjects.

Abdominal Skinfolds

Only the main effects of age and condition were significant on the abdominal skinfolds. Older subjects had significantly larger skinfolds than younger subjects, and subjects with spinal neuromuscular conditions had significantly larger skinfolds than normal subjects.

Subscapular Skinfolds

A significant sex by age by condition effect was obtained for the subscapular skinfold measure (see Figures 3.11C and 3.11D). Sex was a non-significant factor for both groups of subjects. Age was also nonsignificant. Younger spinal neuromuscular boys had significantly larger skinfolds than younger normal boys, and older spinal neuromuscular girls had significantly larger skinfolds than older normal girls.

Right Grip Strength

The three-way sex by age by condition interaction was significant for the right hand grip strength (see Figures 3.11E and 3.11F). Sex was a significant factor for older normal subjects (boys had higher scores than girls), but no other sex differences were observed (differences between spinal neuromuscular boys and girls were significant at the .05 level but not at the .01 level). Regardless of sex or condition, older subjects made significantly higher scores than younger subjects on the right hand grip strength. Normal girls had significantly higher scores than spinal neuromuscular girls at both age groups. Older normal boys significantly surpassed the performance of older spinal neuromuscular boys; however, there was no significant difference between younger normal and spinal neuromuscular boys.

Left Grip Strength

As with the right hand grip strength, the analysis of the left hand grip strength yielded a significant three-way interaction (see Figure 3.11G and 3.11H). Similarly, sex was a significant factor for older normal subjects (boys did better), but no other sex differences were observed. Age was a significant variable for normal subjects and spinal neuromuscular girls (older subjects surpassed the performance of younger subjects), but no such difference was found for spinal neuromuscular boys. Older normal boys achieved significantly higher scores than older spinal neuromuscular boys, but the difference between younger normal and spinal neuromuscular boys was not significant. Conversely, younger normal girls achieved significantly higher scores than younger spinal neuromuscular girls, but the difference between older normal and spinal neuromuscular girls was not significant.

Flexed Arm Hang

Sex was found to be a significant factor for normal subjects (boys exceeded the performance of girls), but no significant sex difference was found for subjects with spinal neuromuscular conditions on the flexed arm hang (see Figure 3.10A). Regardless of sex or condition, age was not a significant variable on this item. Normal subjects performed significantly longer flexed arm hangs than spinal neuromuscular subjects.

Pull-Ups

Sex was a significant factor for normal subjects on the pull-ups (see Figure 3.10B). Normal boys performed more pull-ups than normal girls. This difference was operative for both younger and older subjects (see Figure 3.9A). No significant sex difference was observed for spinal neuromuscular subjects. Boys, regardless of condition, improved significantly with age, but age differences were nonsignificant for girls. Normal boys performed a significantly greater number of pull-ups than spinal neuromuscular boys, but the difference between normal girls and spinal neuromuscular girls was not significant (see Figure 3.10B).

Additional Sex and Age Comparisons Within the Spinal Neuromuscular Group

Univariate F values for spinal neuromuscular sex and age comparisons are presented below in Table 3.14 for four test items (shuttle run, 50-yard dash, softball distance, and long distance run). Comparisons were not made with normal subjects since procedures were vastly modified for some spinal neuromuscular subjects. The multivariate analysis of these data yielded a significant main effect for sex ($p < .000$).

TABLE 3.14. UNIVARIATE F VALUES FOR SPINAL NEUROMUSCULAR SUBJECTS BY SEX AND AGE.

Test Item	Sex	Age	Sex X Age
Shuttle Run	1.13	1.47	1.84
50-Yard Dash	.91	.73	2.03
Softball Distance	28.58*	.62	.24
Long Distance Run	.09	1.26	.02

*Significant at the .01 level.

The data in Table 3.14 indicate that sex was a significant factor (favoring boys) for spinal neuromuscular subjects on the softball throw. No other significant sex or age differences were found on these four items.

Summary

Spinal neuromuscular and normal subjects were compared on seven Project UNIQUE test items. Except for skinfolds, the scores of the normal subjects were generally significantly superior to those of the spinal neuromuscular subjects on the four performance items which were compared. No significant differences, however, were found between younger (10-13) normal and spinal neuromuscular boys on the grip strength measures. In addition, no significant differences were found between older (14-17) normal and spinal neuromuscular girls on left hand grip strength or between normal and spinal neuromuscular girls (both age groups) on pull-ups. Although not all comparisons were significant, there was a trend for spinal neuromuscular subjects to have larger skinfold measures than normal subjects.

Few significant sex and age differences emerged for the spinal neuromuscular group. In fact, only one significant sex difference emerged (boys exceeded the girls on the softball throw). Age was significant for spinal neuromuscular subjects on right hand grip strength (older subjects with higher scores), for spinal neuromuscular girls on left hand grip strength (older subjects with higher scores), and for spinal neuromuscular boys on pull-ups (older boys with higher scores). Relative to skinfold measures, older girls with spinal neuromuscular conditions significantly exceeded younger girls with spinal neuromuscular conditions on triceps and abdominal skinfold. Older boys with spinal neuromuscular conditions significantly exceeded the abdominal skinfold of younger boys. No other significant age differences emerged.

Physical Fitness Test Performance as a Function of Severity and Onset of Handicapping Condition and Methods of Ambulation

The effects of the severity of each of the major handicapping conditions upon physical fitness test performance are presented in this section. The severity of the condition is defined in different ways for each subject group (refer to Chapter II for specific definitions). Auditory impaired subjects were subclassified as either hard of hearing or deaf. Visually impaired subjects were subclassified as either partially sighted or blind. Cerebral palsied subjects were subclassified into one of eight NASCP sport classifications (based upon functional ability) and spinal cord injured subjects (members of the spinal neuromuscular group) were subclassified based upon the site of the spinal cord lesion.

In addition to the severity of the handicapping condition, the effects of two other variables on performance were investigated for certain groups. The effects of different "running" methods were analyzed in regard to the visually impaired and cerebral palsied groups, and the effects of age of onset of handicapping conditions were investigated in regard to the visually impaired group.

Auditory Impaired

In this section, differences between hard of hearing and deaf subjects on Project UNIQUE test items are analyzed. A three-way analysis of variance design classified by sex, age, and condition (hard of hearing or deaf) was used to test the significance of difference between the subgroups of auditory impaired subjects (hard of hearing: boys = 157, girls = 108; deaf: boys = 666, girls = 537). Since sex and age differences of auditory impaired subjects were discussed in a previous section of the report, the main effects of sex and age and the sex by age interaction are of less interest in the present analysis. Of particular interest in the present investigation is the main effect of condition and its possible interaction with sex and age.

The main effect of condition was significant in the multivariate ANOVA ($P < .000$). Univariate ANOVAs were calculated post hoc. The results of the univariate ANOVAs are presented in Table 3.15.

No significant sex by age by condition or sex by condition interactions appear in Table A. On five items (sit-ups, right grip, left grip, standing

TABLE 3.15. UNIVARIATE F VALUES FOR HARD OF HEARING AND DEAF SUBJECTS BY SEX, AGE, AND CONDITION.

Test Items	Sex	Age	Cond.	Sex X Age	Sex X Cond.	Age X Cond.	Sex X Age X Cond.
Triceps Skinfold	86.48*	.47	3.98	3.27	1.69	1.90	1.91
Abdominal Skinfold	14.24*	2.54	1.53	2.43	.13	.39	1.81
Subscapular Skinfold	49.83*	3.85*	.28	1.48	1.70	.68	1.31
Sit-Ups	41.02*	7.63*	.04	1.89	.01	3.85*	1.43
Leg Raise	23.61*	14.09*	.54	.92	.60	1.04	.86
Trunk Raise	.22	1.08	3.31	.63	.02	1.34	.69
Mat Creep	34.23*	5.42*	4.18	1.88	.67	1.97	.55
Shuttle Run	29.72*	9.23*	.01	2.33	.01	1.04	.44
Sit and Reach	16.66*	6.25*	.88	.66	.61	1.05	.68
Right Grip	119.94*	87.13*	2.91	16.31*	.50	4.52*	.51
Left Grip	123.98*	76.85*	8.89*	16.93*	.45	3.54*	.44
Arm Hang	65.82*	9.86*	.87	5.45*	5.54	.91	.99
Pull-Ups	148.39*	10.98*	1.93	10.52*	2.61	.41	.82
50-Yard Dash	34.36*	16.61*	.17	4.22*	.43	1.25	.50
Broad Jump	137.08*	36.35*	.22	10.70*	.42	3.03*	.43
Softball Throw (Dist.)	330.48*	37.87*	.02	4.53*	.44	1.88	.77
Long Distance Run	63.92*	5.00*	.11	4.23*	1.20	2.90*	.65

*Significant at the .01 level.

broad jump, and long distance run), a significant age by condition interaction was obtained. The nature of this interaction is discussed below for each item. Nonsignificant differences between hard of hearing and deaf subjects were found in the remaining 12 items.

Sit-Ups

Both hard of hearing and deaf subjects generally improved with age on the sit-up test. With one exception, the differences between subject groups were nonsignificant. At 16 years of age, deaf subjects ($\bar{X}$=36.73) performed significantly more sit-ups than hard of hearing subjects ($\bar{X}$=29.84).

Right Grip Strength

The mean right hand grip strength score for 10 to 13-year old deaf subjects was slightly higher than that of the 10 to 13-year old hard of hearing subjects; conversely, the mean score for 14 to 17-year old hard of hearing subjects was slightly higher than that of the 14 to 17-year old deaf subjects. None of these differences, however, were significant.

Left Grip Strength

Age was a significant factor for both deaf and hard of hearing subjects on left hand grip strength. At 13 years of age, deaf subjects ($\bar{X}$=22.10) made significantly higher scores than hard of hearing subjects ($\bar{X}$=15.96). No

other significant differences between the subgroups of auditory impaired subjects were observed.

Standing Broad Jump

Generally speaking, older subjects jumped farther than younger subjects regardless of condition. When plotted, the performance curves of hard of hearing and deaf subjects crossed four times across the eight age groups. No significant differences, however, were found between the groups of subjects at any age.

Long Distance Run

Age was a significant factor on the long distance run for both hard of hearing and deaf subjects. As with the standing broad jump, the plotted performance curves crossed a number of times; however, no differences between the groups of subjects were found at any age.

Summary

Thirteen-year old deaf students had significantly higher left hand grip strength scores than 13-year old hard of hearing students, and 16-year old deaf students performed significantly more sit-ups than 16-year old hard of hearing students. With these two exceptions, no significant differences were found between hard of hearing and deaf participants on Project UNIQUE test items.

Visually Impaired

In this section, the effects of selected variables associated with the performance of visually impaired subjects are analyzed. Analyses which investigated differences between partially sighted and blind subjects, the effects of age of onset of the visual impairment on fitness measures, and differences between running methods are presented herein.

To test the significance of differences between partially sighted and blind subjects, a three-way ANOVA design classified by sex, age, and condition (partially sighted or blind) was employed. In this analysis, it was necessary to combine subjects into two age groups (10-13 and 14-17) to maintain acceptable cell sizes. Table 3.16 presents a breakdown of the number of visually impaired subjects entered into this analysis.

TABLE 3.16. NUMBER OF VISUALLY IMPAIRED SUBJECTS CATEGORIZED BY CONDITION, SEX, AND AGE.

Age	Partially Sighted		Blind	
	Girls	Boys	Girls	Boys
10-13	76	131	35	25
14-17	109	173	42	58

The multivariate ANOVA procedure yielded a significant sex by age by condition effect ($p < .011$). Univariate analyses were computed post hoc. The results of the univariate analyses of variance are presented in Table 3.17.

TABLE 3.17. UNIVARIATE F VALUES FOR PARTIALLY SIGHTED AND BLIND SUBJECTS BY SEX, AGE, AND CONDITION.

Test Item	Sex	Age	Cond.	Sex X Age	Sex X Cond.	Age X Cond.	Sex X Age X Cond.
Triceps Skinfold	27.97*	.17	1.47	4.52	1.66	.22	.52
Abdominal Skinfold	1.56	4.32	2.44	.09	.26	.00	.14
Subscapular Skinfold	8.96*	8.60*	1.09	1.06	1.01	.01	.00
Sit-Ups	40.05*	4.77	.82	.02	.29	1.40	1.02
Leg Raise	9.11*	14.46*	.00	6.32	.28	.01	1.34
Trunk Raise	.28	14.43*	5.18	.26	.06	2.15	.97
Mat Creep	29.00*	.01	42.25*	.57	4.36	3.44	.89
Shuttle Run	4.78	36.53*	56.30*	.06	.13	13.36*	.31
Sit and Reach	5.74	8.09*	1.55	.00	1.62	5.11	.18
Right Grip	64.31*	104.28*	3.41	27.37*	.76	.03	.16
Left Grip	53.37*	99.54*	2.91	31.18*	.69	.31	.80
Arm Hang	41.10*	11.71*	.42	3.96	.65	.00	.06
Pull-Ups	72.25*	10.39*	.01	12.79*	1.04	.01	.22
50-Yard Dash	3.52	63.14*	73.95*	9.18*	.60	15.45*	2.89
Broad Jump	66.96*	59.68*	26.03*	4.30	2.76	.33	1.04
Softball Throw (Dist.)	74.62*	39.65*	55.88*	9.10*	2.39	1.12	1.57
Long Distance Run	26.41*	4.98	12.07*	4.58	.32	.01	3.74

*Significant at the .01 level.

Since the effects of sex and age on the performance of visually impaired subjects was presented earlier, they will not be discussed further here. Of primary importance in the present analysis is the main effect of condition and its interaction with sex and age. On six test items--mat creep ($B\bar{x}$=6.82, $PS\bar{x}$=4.56), shuttle run ($B\bar{x}$=16.67, $PS\bar{x}$=13.02), 50-yard dash ($B\bar{x}$=10.58, $PS\bar{x}$=8.89), standing broad jump ($B\bar{x}$=52.83, $PS\bar{x}$=59.93), softball throw for distance ($B\bar{x}$=42.17, $PS\bar{x}$=69.75), and long distance run ($B\bar{x}$=147.54, $PS\bar{x}$=165.12)--the main effect of condition was significant. In each case, the difference favored the partially sighted group. The significant age by condition interaction in the shuttle run and dash is apparently due to the fact that the rate of improvement between younger and older subjects was greater for blind participants than partially sighted participants. No significant difference was found between partially sighted and blind subjects on the other 11 Project UNIQUE test items.

To investigate the effects of the age of onset of the visual impairment upon measures of fitness, a two-way ANOVA design was employed. The variables of age of onset and condition (partially sighted or blind) were entered into the analysis. Age of onset was categorized as (1) occurring congenitally (N=476), (2) occurring between birth and age six (N=125), and (3) occurring

after age 6 (N=48). Since the effects of condition were investigated in the previous analysis, the primary interest in the present analysis is the main effect of age of onset and its interaction with condition. The multivariate ANOVA procedure yielded nonsignificant F values for both age of onset ($p < .289$) and the interaction between age of onset and condition ($p < .238$). Consequently, post hoc univariate procedures were not employed, and it was concluded that age of onset of a visual handicapping condition was not a significant variable in the performance of Project UNIQUE fitness measures.

Visually impaired participants employed one of three running methods when performing the dash, the shuttle run, and the long distance run. Subjects could run with a partner, with the aid of a rope or guide wire, or unassisted. To investigate the effects of running method on the performance of these three items, a one-way univariate ANOVA procedure was utilized. A multivariate procedure was obviated due to the fact that some subjects employed different methods for each running item. The results of the univariate analysis are presented in Table 3.18.

TABLE 3.18. ANALYSIS OF RUNNING METHODS FOR VISUALLY IMPAIRED SUBJECTS.[1]

		Means		
	F Ratio	Partner Assisted	Guide Wire	Unassisted
Shuttle Run (sec.)	34.49*	14.80(2) N=43	18.77(1) N=66	13.04(2) N=462
50-Yard Dash (sec.)	38.17*	10.17(1) N=30	10.98(1) N=109	8.82(2) N=452
Long Distance Run (yds./min.)	4.48**	153.19(1,2) N=76	146.00(2) N=48	163.75(1) N=413

*Significant at .01 level.
**Significant at .012 level.
[1]Numbers in parentheses convey Scheffe' comparisons. Means with the same number in parentheses did not differ significantly; means with different numbers in parentheses differed significantly.

The data presented in Table 3.18 indicate that running method was a significant factor for visually impaired subjects on running items. On the shuttle run, visually impaired subjects who ran either unassisted or with a partner had significantly faster times than subjects who ran with the aid of a guide wire. On the 50-yard dash, subjects who ran unassisted were significantly faster than subjects who ran either with a partner or with the aid of a guide wire. On the long distance run, subjects who ran unassisted averaged a significantly higher number of yards per minute than those who ran with the aid of a guide wire.

Summary

The degree of the visual impairment (partially sighted versus blind) was found to be a significant factor on six of the Project UNIQUE test items. On

each of these items, the difference between the means favored the partially sighted subjects. Five of these items required some form of movement through space (jumping) or moving to a target (running, creeping), and the sixth item involved throwing. Activities which require movement through space (particularly running to visual cues) and throwing have been previously identified as tasks which are particularly difficult for blind children (Winnick, 1979).

The age of onset of the visual impairment was found to be a nonsignificant factor on the performance of the Project UNIQUE test items as indicated by a multivariate analysis. This finding is in conflict with suggestions made by Buell (1950a, 1950b) that children who lose their vision prior to age six have more difficulty adjusting to physical activities than do children who lose their vision after age six. Buell found that this was especially true of running, throwing, and jumping tasks. In consideration of this finding, the five Project UNIQUE test items which required running, throwing, or jumping (dash, shuttle run, long distance run, softball throw, standing broad jump) were entered into a separate multivariate ANOVA to determine if age of onset significantly affected performance in these areas. Neither the main effect of age of onset ($p < .094$) or the interaction between age of onset and severity of condition ($p < .104$) were found to be significant at the .05 level. Age of onset apparently did not significantly influence the performance of visually impaired participants on Project UNIQUE test items.

Subjects who performed the running events unassisted attained superior scores than subjects who ran with the use of a guide wire. Unassisted subjects also significantly exceeded the performance of partner assisted subjects on the 50-yard dash; however, no statistical difference was found between unassisted subjects and partner assisted subjects on either the shuttle run or the long distance run. The performance of partner assisted and guide wire assisted subjects differed significantly only on the shuttle run, where apparently verbal and/or tactual cues provided by the partner were helpful in improving performance on a task requiring changes of direction. The general superiority of unassisted runners is not particularly surprising since logically it is easier to run unencumbered by a partner or a guide wire and also because running method is at least somewhat related to the severity of the condition. While some subjects who were classified as blind did run unassisted, the majority of blind subjects ran with assistance and the majority of the partially sighted subjects ran unassisted.

Since running method was found to be a significant factor, an additional analysis was performed to compare visually impaired subjects who ran unassisted with normal subjects on the three running items. This analysis was performed to verify that differences observed between normal and visually impaired subjects on running items discussed earlier were not due solely to differences in procedures (running methods). This analysis, in fact, confirmed that the differences between visually impaired and normal subjects were significant on all three running items and that this difference was not due to variations in running method.

Cerebral Palsy

This section presents the effects of severity of condition and running methods on the performance of cerebral palsied subjects. Severity of condition was reflected in terms of the 1979 NASCP classification system. Running methods

were recorded based upon the run code system employed in the study and presented earlier.

To determine the effects of the severity of the condition, a one-way univariate ANOVA was employed. (As mentioned earlier, a multivariate analysis was obviated by the fact that not all cerebral palsied subjects were scheduled to take all test items.) Subjects in Classes III through VII were included in the analysis. Class I subjects were omitted because they were only scheduled to take the skinfold measures, and Class II subjects were omitted due to low numbers (N=6). Table 3.20 presents the ANOVA F ratio and, where appropriate, the results of the Scheffe' post hoc comparisons.

The severity of the condition, as defined by the NASCP system, was a significant factor on approximately one-half of the test battery. Significant F ratios were recorded for sit-ups, mat creep, shuttle run, the two grip strength measures, 50-yard dash, standing broad jump (at .018), softball throw, and long distance run. The Scheffe' comparisons (different numbers in parentheses indicate significant differences between classes) suggest that, in general, the higher classes (less severely involved) achieve superior scores when compared to the lower classes on these items. The most notable exception appears to be the performance of Class IV participants on the grip strength measures. Class IV participants are individuals with "good functional strength" in the upper extremities and generally use an assistive device or wheelchair for ambulation. Apparently, the involvement of the hands and arms in ambulation enhanced grip strength performance for these subjects.

Class membership was not a significant factor for the skinfold measures, leg raise, trunk raise, sit and reach, arm hang, or pull-ups.

To analyze the effects of the running method of cerebral palsied subjects on the three running items, a one-way univariate ANOVA procedure was utilized. In this analysis, running methods consisted of (1) wheelchair participation, (2) use of an assistive device (cane, crutches, or walker), and (3) unassisted participation. Table 3.19 presents the results of this analysis.

TABLE 3.19. ANALYSIS OF CEREBRAL PALSY RUNNING METHODS.

Test Item	F Ratio	Wheelchair	Assistive Device	Unassisted
50-Yard Dash (sec.)	31.62*	77.42(1) N=70	36.45(2) N=61	16.94(2) N=122
Shuttle Run (sec.)	94.01*	71.36(1) N=68	45.92(2) N=64	21.13(3) N=144
Long Distance Run (yds./min.)	24.38*	49.08(2) N=35	56.48(2) N=44	93.69(1) N=96

*Significant at the .01 level.

Significant differences were found among running methods on all three running items. Cerebral palsied subjects who ran without assistance made superior scores to subjects who performed in wheelchairs on each running item.

TABLE 3.20. ANALYSIS OF THE PERFORMANCE OF SUBGROUPS OF CEREBRAL PALSIED SUBJECTS.

Test Item	F Ratio	NASCP Classification III N=62	IV N=37	VA N=25	VB N=64	VI N=43	VII N=90
		Means					
Triceps Skinfold (mm.)	.65	13.33	12.58	10.66	13.01	12.42	12.36
Abdominal Skinfold (mm.)	2.34	15.15	15.05	11.94	12.93	11.96	11.15
Subscapular Skinfold (mm.)	1.63	10.82	13.48	10.05	10.82	10.91	10.04
Sit-Ups (no./min.)	22.06*	.86(2)	4.07(2)	7.81(1,2)	3.48(2)	11.36(1)	13.70(1)
Leg Raise (sec.)	2.81	5.06	9.04	7.29	6.25	14.91	11.18
Trunk Raise (sec.)	.78	-	-	-	-	15.17	19.76
Mat Creep (sec.)	16.43*	28.08(1)	25.35(1,2)	14.53(2,3)	14.53(3)	7.79(3)	8.40(3)
Shuttle Run (sec.)	54.55*	82.20(1)	44.71(1,2)	40.46(3,4)	34.42(3,4)	21.12(4,5)	18.45(5)
Sit and Reach (cm.)	1.94	12.65	20.36	18.21	-	16.39	18.04
Right Grip (kg.)	3.64*	10.28(1)	16.73(1)	13.70(1)	15.91(1)	12.84(1)	11.44(1)
Left Grip (kg.)	4.66*	9.02(2)	16.00(1)	13.12(1,2)	16.02(1)	12.00(1,2)	10.99(1,2)
Arm Hang (sec.)	2.89	-	6.00	.61	2.81	1.71	4.43
Pull-Ups (no.)	2.16	-	1.31	.11	.97	.21	1.23
50-Yard Dash (sec.)	15.73*	88.71(1)	43.05(2)	33.47(2)	27.92(2)	15.70(2)	15.29(2)
Broad Jump (in.)	4.12	-	-	21.00(2)	-	28.33(1,2)	32.40(1)
Softball Throw (Dist.) (ft.)	12.69*	13.85(3)	22.47(2,3)	22.86(1,2,3)	24.11(2,3)	33.06(1,2)	37.48(1)
Long Distance Run (yds./min.)	18.24*	35.23(3)	59.43(2,3)	45.24(2,3)	68.22(2)	85.30(1,2)	108.19(1)

*Significant at the .01 level.

Unassisted runners also significantly surpassed the performance of runners who used assistive devices on the shuttle run and long distance run. Despite a 20-second difference in performance, the means of the unassisted and assistive device groups did not differ significantly on the 50-yard dash. Assistive device participants significantly exceeded the performance of wheelchair participants on the 50-yard dash and shuttle run, but no significant difference was found among these groups on the long distance run.

Since running method was found to be a significant factor for cerebral palsied subjects, an additional analysis was performed to confirm that differences on running items between normal and cerebral palsied subjects reported earlier could not be solely attributable to differences in procedure. In this analysis, only unassisted cerebral palsied runners were contrasted with normal runners. The main effect of condition remained significant for each of the running items; the differences observed between normal and cerebral palsied subjects (favoring normal subjects) on running items were not due solely to differences in running procedure.

Summary

This section of the report discussed differences among classes of cerebral palsied subjects and differences among running methods employed by cerebral palsied subjects. Differences among classes of cerebral palsied subjects were identified for all items which required movement through space (running, creeping, and jumping). In addition, class membership was significant for sit-ups, softball throw, and the grip strength items. No other class differences were identified. Generally, it was found that cerebral palsied subjects who ran unassisted surpassed the performance of subjects who ran with the aid of assistive devices or used a wheelchair. This is not a surprising finding, since method of ambulation is somewhat related to the severity of the condition. Perhaps, of greater interest, is the finding that subjects who used assistive devices were significantly faster than their wheelchair counterparts over a shorter distance (shuttle run or dash), but not over a longer distance (long distance run).

Spinal Neuromuscular

This section of the report examines the effects of severity of condition on the performance of spinal neuromuscular subjects whose level of spinal cord involvement was known. Severity of condition was defined by the site of spinal cord lesion and was similar to the classification system utilized by the National Wheelchair Athletic Association. The site of spinal cord lesion was operationally defined by the following categories: (1) all cervical lesions (N=7), (2) lesions between T1 and T5 inclusive (N=5), (3) lesions between T6 and T10 inclusive (N=36), (4) lesions between T11 and L2 inclusive (N=39), and (5) lesions at L3 or below (N=33). A relatively low number of subjects, however, in the first two categories obviated their inclusion in the analysis.

A one-way multivariate analysis was performed. The dependent variables were the 11 Project UNIQUE test items deemed appropriate for paraplegic spinal cord injured subjects (see participation guide), and the independent variable was the site of spinal cord lesion. The multivariate ANOVA indicated that the site of lesion was not a significant factor ($p < .691$) on Project UNIQUE test performance. The test battery, therefore, did not discriminate between spinal cord injured participants with lesions occurring at T6 or below.

Physical Fitness Test Performance as a Function of Community Size and Educational Environment

This section of the report presents differences in performance on Project UNIQUE test items as a function of either community size (normal subjects) or educational environment (impaired subjects). Differences on these variables were analyzed, and are presented separately for each subgroup. For normal subjects, community size was conceptualized and defined as either urban (population of 200,000 or greater), suburban (population equal to or greater than 10,000 but less than 200,000), and rural (population less than 10,000). For impaired subjects, educational environment was defined essentially by school placement and residence. Impaired subjects were classified as either institutionalized residents (IR), institutionalized nonresidents (INR), or non-institutionalized (NI). A subject was considered to be "institutionalized" if all of the students attending his/her school were handicapped. In this context, therefore, an "institution" could be either a public or private segregated school. A subject was considered "non-institutionalized" if normal pupils attended the same school. This was true even if the subject was educated in a self-contained special class in that school. Subjects were classified as residents if they resided at the school or agency rather than away from the school or agency.

In each analysis, a two-way analysis of covariance design was employed. Community size or educational environment and sex served as the independent variables, and age served as the covariate. Age was covaried in an effort to account for possible differences in age distribution within the subgroups of educational environment and sex. With the exception of the cerebral palsied group, a multivariate ANCOVA was calculated initially.

Normal

A sex by community size breakdown of the number of normal subjects in this analysis is presented in Table 3.21.

TABLE 3.21. NUMBER OF NORMAL SUBJECTS CATEGORIZED BY SEX AND COMMUNITY SIZE.

Community Size	Girls	Boys
Urban	180	92
Suburban	319	304
Rural	182	115

The multivariate ANCOVA yielded a significant ($p < .000$) community size by sex interaction for normal subjects. Univariate F values were calculated post hoc. The results of the univariate analysis are presented in Table 3.22.

The data in Table 3.22 indicate that community size was a significant factor on a number of Project UNIQUE test items. Three items--leg raise, trunk raise, and standing broad jump--had significant main effects for community size in the absence of significant interaction. The 99% confidence intervals for the adjusted means for the urban, suburban, and rural subgroups were

TABLE 3.22. MEANS AND UNIVARIATE F VALUES ADJUSTED FOR AGE FOR NORMAL SUBJECTS BY SEX AND COMMUNITY SIZE.

	Means			F Ratio			
Test Item	Urban	Suburban	Rural	Covariate Age	Sex	Community Size	Sex X Community Size
Triceps Skinfold	16.66	12.04	12.36	.07	9.95*	37.13*	5.25*
Abdominal Skinfold	17.00	11.93	12.76	6.16***	30.50*	23.16*	9.17*
Subscapular Skinfold	13.06	9.51	10.78	17.47*	10.23*	28.32*	5.95*
Sit-Ups	35.95	39.57	35.68	59.74*	90.75*	17.18*	5.42*
Leg Raise	35.93	42.22	36.15	87.05*	21.13*	6.54*	2.63
Trunk Raise	39.26	56.08	48.03	7.89*	.11	19.66*	1.91
Mat Creep	4.30	3.70	3.91	10.51*	172.77*	35.84*	4.42**
Shuttle Run	11.14	11.03	11.14	79.84*	112.20*	1.23	.47
Sit and Reach	28.28	27.89	28.20	69.67*	160.64*	.29	1.47
Right Grip	23.12	26.15	26.43	1146.92*	259.94*	9.38*	4.48**
Left Grip	20.38	23.17	23.18	953.42*	240.53*	6.91*	6.51*
Arm Hang	11.49	12.39	16.77	.92	178.75*	18.73*	14.84*
Pull-Ups	2.22	2.62	2.44	61.91*	398.32*	1.90	.54
50-Yard Dash	8.04	8.04	8.07	175.46*	135.08*	.09	.12
Standing Broad Jump	67.46	65.55	63.46	394.18*	285.04*	11.31*	1.96
Softball Distance	95.52	97.73	94.41	383.40*	646.57*	1.08	2.51
Long Distance Run	178.70	188.24	185.36	44.76*	216.47*	3.66	.12

*Significant at the .01 level.
**Significant at the .012 level.
***Significant at the .013 level.

contrasted on these items to determine where significant differences occurred. This technique failed to identify any significant differences on the timed leg raise; however, when the confidence intervals were reduced to the 95% level, suburban subjects were found to have significantly higher scores than either urban or rural subjects. On the timed trunk raise, suburban subjects were found to be superior to urban subjects at the 99% level. Urban subjects exceeded the performance of suburban and rural subjects on the standing broad jump.

Significant community size by sex interactions emerged on eight additional variables. The nature of this interaction is discussed briefly below for each item.

Triceps Skinfold

Urban girls had significantly larger skinfolds than either suburban or rural girls. The difference between suburban and rural girls was not significant. No significant community size differences existed among the boys.

Abdominal Skinfold

As with the triceps measure, urban girls had significantly larger skinfolds than either suburban or rural girls. No other significant differences were found.

Subscapular Skinfold

On the subscapular measure, urban girls were found to have significantly larger skinfolds than rural girls, and rural girls were found to have significantly larger skinfolds than suburban girls. No significant differences were found among the boys.

Sit-Ups

Suburban boys had significantly higher sit-up scores than either urban or rural boys. Urban and rural boys did not differ significantly, and no significant differences were found among the girls.

Mat Creep

Suburban and rural girls recorded significantly faster mat creep times than urban girls. Suburban boys were significantly faster than urban boys, but rural boys did not differ significantly from either of the other groups.

Right and Left Grip Strength

Rural girls had significantly higher grip strength scores than urban girls. Suburban girls did not differ significantly from either of the other groups. No significant differences existed among the boys.

Flexed Arm Hang

Rural boys had significantly higher flexed arm hang times than either urban or suburban boys. No significant differences among girls were found.

Summary

Significant differences in performance by community size were found in 11 of the 17 test items. A somewhat greater number of differences existed for girls than boys. A clear pattern of differences was not apparent for the boys. Where community size differences existed for the girls, however, there appeared to be a tendency for the performance of urban girls to be inferior to that of suburban and rural girls. The standing broad jump test was the only exception to this tendency.

Auditory

A sex by educational environment breakdown of the number of auditory impaired subjects in this analysis is presented in Table 3.23.

TABLE 3.23. NUMBER OF AUDITORY IMPAIRED SUBJECTS CATEGORIZED BY SEX AND EDUCATIONAL ENVIRONMENT.

Educational Environment	Girls	Boys
Institutionalized Resident	365	480
Institutionalized Nonresident	197	227
Non-Institutionalized	83	116

The multivariate ANCOVA yielded a significant ($p<.000$) educational environment by sex interaction for auditory impaired subjects. The results of the post hoc univariate analysis are presented in Table 3.24.

The data in Table 3.24 indicate that educational environment was a significant factor on most Project UNIQUE test items. Eleven test items yielded significant main effect F values for educational environment in the absence of significant interaction. On sit-ups, mat creep, shuttle run, right grip strength, and 50-yard dash, institutionalized residents and institutionalized nonresidents made significantly superior scores when compared to non-institutionalized subjects. No significant differences emerged between the two institutionalized samples on these items.

On the triceps skinfold, institutionalized residents had significantly larger skinfolds than institutionalized nonresidents. No differences were found for the abdominal skinfold using 99% confidence intervals; however, institutionalized residents had significantly larger skinfolds than institutionalized nonresidents and non-institutionalized subjects at the .05 level. Institutionalized residents exceeded the performance of non-institutionalized subjects on the leg raise and exceeded the performance of both institutionalized nonresidents and non-institutionalized subjects on the flexed arm hang. On the trunk raise, institutionalized nonresidents made significantly higher scores than institutionalized residents. On the softball throw, institutionalized residents significantly outdistanced institutionalized nonresidents, and the institutionalized nonresidents significantly outdistanced the non-institutionalized subjects. No other significant differences among groups were observed for these items.

TABLE 3.24. MEANS AND UNIVARIATE F VALUES ADJUSTED FOR AGE FOR AUDITORY IMPAIRED SUBJECTS BY SEX AND EDUCATIONAL ENVIRONMENT.

	Means			F Ratio			
Test Item	IR	INR	NI	Covariate Age	Sex	Educational Environment	Sex X Educational Environment
Triceps Skinfold	14.72	13.28	14.87	.05	162.16*	7.52*	3.18
Abdominal Skinfold	15.79	14.22	13.78	17.83*	27.13*	6.80*	.47
Subscapular Skinfold	12.36	12.09	13.03	46.45*	67.49*	1.49	.45
Sit-Ups	33.68	33.21	25.42	60.02*	76.78*	47.16*	.22
Leg Raise	36.11	33.92	26.93	116.03*	46.10*	9.53*	.54
Trunk Raise	40.46	48.28	38.01	17.81*	1.69	8.77*	.25
Mat Creep	3.98	3.91	5.23	23.64*	67.21*	109.47*	.95
Shuttle Run	11.25	11.18	13.42	93.05*	73.71*	110.57*	.03
Sit and Reach	26.13	26.50	24.74	64.79*	19.91*	2.92	.76
Right Grip	26.68	28.98	22.15	837.54*	206.00*	37.06*	3.15
Left Grip	24.48	26.88	19.44	763.36*	210.64*	47.43*	4.58*
Arm Hang	13.85	10.88	9.12	73.75*	170.03*	14.36*	2.46
Pull-Ups	2.77	2.36	2.19	125.80*	274.81*	3.58	7.55*
50-Yard Dash	7.91	8.04	9.69	191.31*	94.87*	135.87*	.83
Standing Broad Jump	63.54	65.23	61.00	409.90*	246.04*	10.99*	6.47*
Softball Distance	90.05	98.13	84.37	421.72*	517.97*	14.11*	2.93
Long Distance Run	184.80	168.57	154.38	24.05*	146.31*	27.48*	9.02*

*Significant at the .01 level.

In addition, a significant educational environment by sex interaction emerged on four items. Each of these items is discussed briefly below.

Left Grip Strength

Institutionalized nonresident girls had significantly higher left hand grip strength scores than girls from either the institutionalized resident or non-institutionalized groups. Boys from the two institutionalized groups exceeded the performance of non-institutionalized boys on left hand grip strength.

Pull-Ups

Institutionalized resident boys performed a significantly greater number of pull-ups than non-institutionalized boys. No other significant differences were identified for this test item.

Standing Broad Jump

Institutionalized resident girls jumped significantly farther on the standing broad jump than institutionalized nonresident girls. Boys from the two institutionalized groups jumped significantly farther than boys from the non-institutionalized group.

Long Distance Run

Institutionalized resident boys covered a significantly greater number of yards per minute on the long distance run than boys from either the institutionalized nonresident or non-institutionalized groups. No other significant differences were observed.

Summary

Educational environment was found to be a significant factor for auditory impaired subjects on 15 of the 17 Project UNIQUE test items. While the superiority of groups and subgroups varied from item to item, there was a definite trend that the performance of non-institutionalized subjects was generally inferior to the performance of institutionalized subjects. On 12 of the 13 performance items (skinfolds excluded), the performance of non-institutionalized subjects was surpassed by the performance of at least one of the institutionalized groups. In general, therefore, it appears that auditory impaired subjects who attended segregated facilities were more successful on Project UNIQUE test items than those who attended school in integrated settings.

Visual

A sex by educational environment breakdown of the number of visually impaired subjects in this analysis is presented in Table 3.25.

The multivariate ANCOVA yielded a significant ($p < .000$) main effect of educational environment for the visually impaired group. A univariate analysis was performed post hoc. The results of this analysis are presented in Table 3.26.

TABLE 3.25. NUMBER OF VISUALLY IMPAIRED SUBJECTS CATEGORIZED BY SEX AND EDUCATIONAL ENVIRONMENT.

Educational Environment	Girls	Boys
Institutionalized Resident	146	242
Institutionalized Nonresident	40	47
Non-Institutionalized	76	98

As indicated by the data in Table 3.26, approximately one-half (nine of 17) of the variables yielded significant main effects for educational environment. Sex did not interact with educational environment on any of the variables. Levels of educational environment were contrasted by comparing the 99% confidence intervals of the adjusted means on each of the ten significant variables.

On each of the skinfold measures, institutionalized residents were found to have significantly larger skinfolds than non-institutionalized subjects. Subjects from the two institutionalized groups (resident and nonresident) made significantly higher scores than non-institutionalized subjects on sit-ups and the two grip strength measures. On leg raise and long distance run, institutionalized residents significantly surpassed the performance of non-institutionalized subjects; and on flexed arm hang, institutionalized nonresidents exceeded the performance of non-institutionalized subjects. No differences were found between the subgroups of educational setting for the 50-yard dash.

Summary

Educational environment was found to be a significant factor on nine of the 17 test items. Although educational environment was not significant on as many variables for visually impaired subjects as for auditory impaired subjects, the trend for the institutionalized groups to be superior to the non-institutionalized groups was apparent in each analysis. Of the six performance items where educational environment was significant for the visually impaired, the non-institutionalized group was found to be inferior to at least one of the institutionalized groups in every case. Visually impaired subjects who attended school in segregated settings were more successful on certain Project UNIQUE test items than were visually impaired subjects who attended school in integrated settings.

Cerebral Palsy

A sex by educational environment breakdown of the number of cerebral palsied subjects in this analysis is presented in Table 3.28.

The results of the univariate ANCOVA designed to investigate the effect of educational setting on the test performance of cerebral palsied subjects are presented in Table 3.27.

As shown by the data in Table 3.27, the main effect of educational setting was significant on only three test items--mat creep, shuttle run, and right hand

TABLE 3.26. MEANS AND UNIVARIATE F VALUES ADJUSTED FOR AGE FOR VISUALLY IMPAIRED SUBJECTS BY SEX AND EDUCATIONAL ENVIRONMENT.

	Means			F Ratio			
Test Item	IR	INR	NI	Covariate Age	Sex	Educational Environment	Sex X Educational Environment
Triceps Skinfold	15.49	13.94	12.84	.05	30.48*	7.58*	.16
Abdominal Skinfold	16.60	14.69	12.72	9.31*	1.61	8.34*	.11
Subscapular Skinfold	13.91	12.36	11.19	15.58*	7.37*	7.24*	.06
Sit-Ups	32.95	34.17	28.71	20.16*	31.96*	11.72*	1.19
Leg Raise	36.77	25.72	20.71	30.92*	4.84	16.65*	1.22
Trunk Raise	32.80	37.38	30.49	18.35*	1.20	1.30	1.13
Mat Creep	4.84	4.90	5.42	.87	10.25*	3.87	3.36
Shuttle Run	14.33	13.19	13.52	22.87*	9.40*	1.86	.15
Sit and Reach	25.86	26.07	25.32	4.02	5.71	.27	1.52
Right Grip	22.16	23.62	18.13	288.49*	70.69*	16.26*	2.75
Left Grip	19.96	21.35	16.36	270.98*	63.21*	14.35*	1.20
Arm Hang	9.98	14.83	7.10	27.94*	42.54*	10.79*	.62
Pull-Ups	2.28	2.65	1.60	34.08*	91.97*	4.03	1.96
50-Yard Dash	9.62	9.15	8.95	51.73*	12.41*	4.54**	.98
Standing Broad Jump	57.08	60.03	55.28	111.23*	72.14*	2.96	.17
Softball Distance	58.95	59.92	62.29	101.21*	92.21*	.56	2.39
Long Distance Run	163.77	152.14	148.32	11.71*	29.63*	7.13*	.94

*Significant at the .01 level.
**Significant at the .011 level.

TABLE 3.27. MEANS AND UNIVARIATE F VALUES ADJUSTED FOR AGE FOR CEREBRAL PALSIED SUBJECTS BY SEX AND EDUCATIONAL ENVIRONMENT.

	Means			F Ratio			
Test Item	IR	INR	I	Covariate Age	Sex	Educational Environment	Sex X Educational Environment
Triceps Skinfold	14.54	13.13	11.93	.15	12.90*	3.51	.16
Abdominal Skinfold	15.40	13.25	12.13	13.47*	6.09**	3.28	.65
Subscapular Skinfold	12.77	11.07	10.36	12.98*	2.41	2.85	.19
Sit-Ups	3.84	5.79	7.93	4.24	.71	2.71	1.65
Leg Raise	8.37	13.56	8.11	.11	2.66	2.76	.32
Trunk Raise	15.39	7.69	15.58	3.51	.16	.44	1.65
Mat Creep	19.30	23.03	12.96	.97	1.37	7.54*	3.22
Shuttle Run	47.62	62.90	36.06	.42	.03	13.56*	.67
Sit and Reach	21.90	16.51	17.64	.00	.76	.94	.03
Right Grip	15.02	9.19	12.71	88.04*	4.73	4.84*	.29
Left Grip	13.50	8.65	12.42	69.29*	8.56*	4.31**	.69
Arm Hang	2.30	2.99	2.91	5.43	6.69*	.36	.12
Pull-Ups	.75	.63	.75	4.56	7.61*	.01	.55
50-Yard Dash	34.06	58.86	38.91	3.85	1.65	1.16	.60
Standing Broad Jump	31.85	31.41	27.54	.31	2.21	.97	.17
Softball Distance	22.49	19.45	26.58	8.97*	11.55*	2.57	.98
Long Distance Run	85.35	64.50	74.82	2.97	.21	.39	2.09

*Significant at the .01 level.

**Significant at the .014 level.

TABLE 3.28. NUMBER OF CEREBRAL PALSIED SUBJECTS CATEGORIZED BY SEX AND EDUCATIONAL ENVIRONMENT.

Educational Environment	Girls	Boys
Institutionalized Nonresident	21	25
Institutionalized Resident	38	46
Non-Institutionalized	119	147

grip strength. On the mat creep and shuttle run, non-institutionalized subjects made significantly faster times than institutionalized nonresidents. No 99% confidence level differences were found on the right hand grip strength; however, at the 95% level, institutionalized residents had significantly higher scores than institutionalized nonresidents.

Summary

Educational environment does not appear to be as significant a factor for cerebral palsied subjects as it was for sensory impaired subjects. The differences observed on the mat creep and shuttle run may have been a function of ambulatory ability since approximately 61 percent of all institutionalized cerebral palsied subjects utilized wheelchairs, while only 32 percent of all non-institutionalized cerebral palsied subjects utilized wheelchairs. At any rate, whether a subject with cerebral palsy attended school in a segregated setting or in an integrated setting, educational environment had relatively little to do with his/her performance on the test battery.

Spinal Neuromuscular

A sex by educational environment breakdown of the number of spinal neuromuscular subjects in this analysis is presented in Table 3.29.

TABLE 3.29. NUMBER OF SPINAL NEUROMUSCULAR SUBJECTS CATEGORIZED BY SEX AND EDUCATIONAL ENVIRONMENT.

Educational Environment	Girls	Boys
Institutionalized Nonresident	8	10
Institutionalized Resident	18	16
Non-Institutionalized	47	48

A multivariate ANCOVA was calculated for subjects with spinal neuromuscular conditions to assess the effects of educational environment on fitness test performance. The analysis indicated that neither the interaction of educational setting and sex ($p < .148$) nor the main effect of educational environment ($p < .314$) was significant. The univariate ANCOVA, therefore, was not performed and it was concluded that educational environment was not a significant factor for fitness test performance for subjects with spinal neuromuscular conditions.

Additional Descriptive Statistics

This section presents additional descriptive statistics which further serve to detail differences between the major subgroups. Specifically, the magnitude of differences between normal and impaired subjects expressed in standard deviation units is discussed. Also, coefficients of variation were calculated for each item in each subject group and are presented in this section. Finally, the percentages of impaired subjects whose performance surpassed the median score of normal subjects for each test item is presented.

Magnitude of Differences of Individuals with Handicapping Conditions and Normal Subjects Expressed in Standard Deviation Units

In order to identify and analyze the magnitude of differences in test items between subjects with impairments and normal individuals, results on variables have been expressed in standard deviation units. The results represent the standard deviation units, or fractional parts thereof, that mean scores of the impaired on a particular test item differ from the mean score of normal children of the same sex on that test item. The results of these computations appear in Table 3.30. In Table 3.30, individuals with auditory impairments, visual impairments, cerebral palsy, spinal neuromuscular conditions, and congenital anomalies/amputations are compared with the results attained by normal subjects. The standard deviation units which are presented in the table are computed by subtracting the mean raw scores of males or females of each of the categories of normal subjects from the corresponding mean raw score of male or female subjects with impairments and dividing the difference by the standard deviation of the corresponding sex group in the normal sample. Thus, a zero score represents the standard mean value for normal boys and girls. In the table, the lack of sign represents a standard deviation unit above the mean, and the minus sign (-) represents a standard deviation unit below the mean. Units above the mean should not indiscriminantly be interpreted to denote desirable performance. In some cases, negative signs reflect low scores which indicate superior performance. This is true in the case of [illegible] events including the 50-yard dash, mat creep, and shuttle run. Skinfold measures below the mean (negative sign) will generally be desirable; however, extreme [illegible] or negative scores may be undesirable.

The comparisons shown in Table 3.30 do not distinguish subjects in terms of the procedures followed in test administration. Thus, for example, subjects performing dashes in wheelchairs or running with a sighted partner are compared in this table with normal youngsters running the dash unassisted. (In cases where subjects performed test items with modifications, results are analyzed in greater detail in an earlier section of this report.)

In relationship to comparisons between individuals with auditory impairments and normal subjects, the information in Table 3.30 indicates that the performance of the auditory impaired is relatively close to that of normal subjects. The magnitude of differences between normal and auditory impaired subjects in no case exceeds one standard deviation. In fact, most of the differences between these groups do not exceed a magnitude of difference greater than 0.25. Although not tested for statistical significance, there appear to be greater differences between auditory impaired and normal girls than between

TABLE 3.30. MAGNITUDE OF DIFFERENCES EXPRESSED IN S.D. SCALE UNITS BETWEEN SUBJECTS WITH IMPAIRMENTS AND NORMAL SUBJECTS ON PROJECT UNIQUE TEST ITEMS.

Test Item	Auditory Impairments		Visual Impairments		Cerebral Palsy		Spinal Neuromuscular		Congenital Anomalies/ Amputee	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Triceps Skinfold*	0.41	-0.12	0.37	0.05	0.01	-0.27	0.31	0.46	0.29	0.02
Abdominal Skinfold*	0.25	0.26	0.17	0.45	-0.06	-0.03	0.32	0.79	0.23	0.45
Subscapular Skinfold*	0.51	0.14	0.49	0.41	0.05	0.04	0.44	0.88	0.47	0.43
Sit-Ups	-0.58	-0.61	-0.65	-0.62	-3.12	-3.21	-	-	-3.04	-2.72
Leg Raise	-0.24	-0.12	-0.32	-0.23	-0.99	-1.04	-	-	-0.64	-0.84
Trunk Raise	-0.25	-0.18	-0.52	-0.45	-0.80	-1.39	-	-	-0.97	-0.94
Mat Creep*	0.22	0.50	1.44	1.67	14.00	16.50	-	-	6.33	9.67
Shuttle Run*	0.45	0.25	3.00	2.08	27.82	21.67	21.09	22.92	14.45	8.67
Sit and Reach	-0.49	-0.03	-0.53	-0.06	-1.50	-1.00	-	-	-0.74	-0.64
Right Grip	0.03	0.05	-0.59	-0.38	-1.34	-1.17	-0.96	-0.49	-0.76	-0.91
Left Grip	0.12	0.12	-0.48	-0.35	-1.19	-1.01	-0.84	-0.47	-0.74	-0.69
Arm Hang	-0.18	-0.12	-0.26	-0.34	-0.68	-0.80	-0.52	-0.71	-0.39	-0.76
Pull-Ups	-0.06	0.06	0.00	-0.19	-0.22	-0.81	0.05	-0.56	0.33	-0.64
50-Yard Dash*	0.17	0.18	1.17	1.18	32.92	19.73	16.58	22.91	20.67	9.09
Broad Jump	-0.30	-0.02	-0.96	-0.57	-3.47	-2.87	-	-	-3.58	-22.69
Softball Distance	-0.04	-0.17	-0.94	-1.00	-1.81	-1.95	-1.87	-1.91	-1.55	-1.45
Long Distance Run	-0.63	-0.72	-0.69	-0.86	-1.05	-1.31	-1.05	-1.33	-0.95	-1.32

*Except in the case of skinfold measures, low scores (negative S.D. unit) on these items denote superior performance. Extreme positive or negative skinfold scores are undesirable. Generally, skinfold measures below the mean (negative sign) are desirable.

auditory impaired and normal boys. Also, girls with auditory impairments appear to perform below normal girls on more items than boys with auditory impairments relative to normal boys. As a group, individuals with auditory impairments appear to fall behind, to the greatest extent, on test items which involve running. Individuals with auditory impairments appear to compare favorably to normal subjects in grip strength.

When comparing the results of subjects with visual impairments with results attained by normal subjects, it becomes apparent that normal individuals exceed the performance of subjects with visual impairments on many test items. The magnitude of difference between the visually impaired and the normal is generally greater than that between the auditory impaired and the normal. These results support the contention that normal individuals as a group, are leaner, possess greater muscular strength and endurance, more flexibility, and greater agility and speed than subjects with visual impairments. The largest differences occur in softball distance and in those test items involving moving to a target in the fastest possible time. The results pertaining to the softball throw are in agreement with those found in previous research and are evidently accounted for by a learning factor. The fact that individuals with visual impairments score lower than individuals with normal vision on items requiring them to run from one place to another is, of course, expected. Individuals moving without the benefit of sight and with the need to use guide wires, partners, or other assistive devices are at a disadvantage. The magnitude of difference between normal boys and those with visual impairments is least in items pertaining to flexibility, certain items involving muscular strength/endurance, and skinfold measurements. In regard to girls, the magnitude of differences is smallest in pull-ups. This could be attributed to the fact that neither group performed well on this test item.

Of the specific handicapping groups compared, individuals with orthopedic impairments exhibited the greatest differences from normal subjects. From the data presented in Table 3.30, it can be clearly seen that the various subgroups comprising orthopedic impairments are within one standard deviation unit of the performance of normal subjects on items where similar procedures were followed. However, when orthopedically impaired youngsters performed test items with modifications, the magnitude of differences were increased greatly. In test items such as the 50-yard dash or shuttle run, the differences are very large. This is expected since individuals who perform these activities in a wheelchair or with some assistive device are at a tremendous disadvantage when compared with youngsters without lower body disabilities. Thus, the magnitude of differences must be attributed to differences in methods of ambulation as well as possible differences in fitness. The orthopedic groups come closest to the normal groups in skinfold measurements.

In the case of subjects with cerebral palsy, it is apparent that individuals with cerebral palsy are relatively close to normal subjects in the area of body composition. Relative to test items measuring muscular strength/endurance, individuals with cerebral palsy are generally between one and two standard deviations below the performance of normal subjects. In the case of sit-ups and broad jump, the magnitude of differences exceeds or approaches three standard deviation scale units. It is possible that these results may be influenced by the inadequate inhibition of reflex patterns.

In the case of items requiring subjects to ambulate for a particular distance or time, individuals with cerebral palsy are far below the performance of normal subjects. Although this might be attributed, to some extent, to differences in physical fitness, certainly the fact that individuals with cerebral palsy performed these activities in wheelchairs and with assistive devices (i.e., with modifications) is a factor in the large discrepancy.

Individuals with spinal neuromuscular conditions come closer to the performance of normal subjects than do individuals with cerebral palsy; however, they also exhibit relatively large differences in regard to certain items dealing with body composition and muscular strength/endurance. On dashes and the shuttle run, the performance of individuals with spinal neuromuscular conditions is much different than that of normal subjects. Again, this may be attributed, to a great extent, to the fact that these activities were performed in wheelchairs and that the activities are characterized by starts and stops in a relatively short period of time, requiring the constant overcoming of inertia. Interestingly, the discrepancy between performance of normal subjects and performance of individuals with spinal neuromuscular conditions on the long distance run (yards per minute) was less (slightly above one standard deviation) than found in other timed items relative to ambulation. Evidently, when the distance is increased, the discrepancy between normal and wheelchair performers decreases.

In regard to individuals with congenital anomalies or amputations, results are similar to those found with the other two groups included in the orthopedic category.

In summary, individuals with auditory impairments are closer to the performance of normal subjects than individuals from the other groups. Individuals with auditory impairments are generally followed in comparative performance by individuals with visual impairments. Individuals with cerebral palsy exhibit performance closest to normal performance than any of the other groups in the skinfold test items. On the other hand, the sit-up performance of individuals with cerebral palsy deviates more from normal performance than any other impaired group. The cerebral palsy group is also the weakest as expressed by scores on grip strength and arm hang. The cerebral palsied and individuals with congenital anomalies/amputations are extremely different from normal subjects in broad jump performance. Individuals with orthopedic impairments performing the softball throw from a seated position deviate, to a great extent, from normal performance. The difference between normal subjects' performance and the performance of visually handicapped individuals in the softball throw is relatively large. Finally, meaningful comparisons must be limited in cases where test items have been significantly modified for individuals with handicapping conditions. Meaningful analysis in these cases must consider each modification. This analysis was performed in other sections of this report.

Variability and the Performance of Test Items

It has long been accepted that individuals with handicapping conditions are more variable in their performance on physical fitness related test items than normal individuals. It is also expected that the extent of variability will be a function of the particular variable being measured. To provide comparable data on the variability of performance of subjects included in this

study, coefficients of variation were computed and are presented in Table 3.31. The coefficient of variation enables data to be arranged into units which may be compared, i.e., data is transferred to the same scale of measurement with the same units. The coefficient of variation is determined by multiplying the standard deviation of a sample by 100 and dividing by the mean of the sample. Essentially, this procedure provides a statistic which indicates the variability of one sample in relationship to its mean. This statistic enhances comparison to a second sample in relationship to its mean.

The coefficients of variation in relationship to Project UNIQUE Physical Fitness Test items are presented in Table 3.31. Generally, the results indicate that individuals with handicapping conditions are more variable than normal subjects in their physical performance. This becomes particularly obvious in comparing normal subjects with individuals with orthopedic impairments. With few exceptions, the variation in performance of cerebral palsied youngsters and youngsters with congenital anomalies/amputations far exceeds the variation of normal boys and girls. It should be mentioned that although the results might be due to the wider variation in physical fitness of handicapped youngsters as compared to normal youngsters, it is also important to realize that variation is influenced by the varying procedures under which individuals with handicapping conditions performed the test items. For example, it is not surprising that the coefficient of variation of running items for individuals with visual impairments exceeds that of normal individuals, because individuals with these impairments performed these activities with a partner, guide wire, or with no assistance. Individuals with orthopedic impairments performed dashes and other events in a variety of modalities.

Different test items tend to elicit greater or lesser variation in performance. The test items which elicit the least variation in performance include the broad jump and dashes (except for individuals with orthopedic impairments), long distance run in yards per minute (except for normal subjects and certain groups of subjects with orthopedic impairments), and the shuttle run (except for individuals with visual and orthopedic impairments). The mat creep is an item which varies relatively little in the case of normal subjects. Skinfold and sit and reach test items are among those which vary least when comparisons are made within the orthopedic classes.

Test items eliciting greatest variation are quite definite. The flexed arm hang, pull-ups, leg raise, and trunk raise are items which elicit relatively great variation across all or most subject groups.

In summary, it is clear from Table 3.31 that individuals with handicapping conditions exhibit greater variation in performance than normal subjects. Variability also tends to increase in test items in which individuals perform items under different conditions and in which subjects are asked to hold certain positions for indefinite periods of time.

Percent of Subjects with Handicapping Conditions Scoring Higher than Median Values of Normal Subjects

In comparing the performance of individuals with handicapping conditions and normal subjects, a great deal of attention is placed on the analysis of group performances and upon the mean and standard deviation as measures of

TABLE 3.31. COEFFICIENTS OF VARIATION OF TEST ITEMS.

Variables	Normal		Auditory Impairments		Visual Impairments		Spinal Neuromuscular		Cerebral Palsy		Congenital Anomalies/ Amputees	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
Triceps Skinfold	50.65	41.40	40.93	50.16	49.70	55.30	47.86	49.55	51.26	53.17	41.66	65.55
Abdominal Skinfold	58.38	55.93	46.87	64.02	61.22	73.59	70.33	52.15	56.71	73.81	39.85	86.60
Subscapular Skinfold	51.60	48.79	43.94	53.56	55.59	67.15	64.06	54.52	55.04	64.60	37.54	70.73
Sit-Ups	26.68	24.85	36.34	33.17	33.01	32.76	-	-	146.24	121.17	137.98	100.82
Leg Raise	76.85	74.84	76.39	76.87	106.99	98.00	-	-	133.79	183.94	136.90	116.49
Trunk Raise	71.25	71.73	81.09	81.70	101.22	93.19	-	-	167.22	103.41	191.70	148.72
Mat Creep	20.62	17.58	27.37	31.19	54.44	33.20	-	-	112.30	98.87	75.76	115.27
Shuttle Run	9.43	10.82	17.27	19.39	38.20	41.31	37.38	90.45	70.69	94.17	70.69	53.21
Sit and Reach	25.63	31.13	31.23	35.43	32.72	37.27	-	-	63.79	55.90	43.17	49.69
Right Grip	35.59	45.34	38.77	44.76	44.51	48.71	59.58	61.68	72.19	76.32	58.12	71.29
Left Grip	37.90	48.05	40.19	45.95	46.13	51.38	62.67	69.47	78.44	76.33	74.87	83.84
Flexed Arm Hang	120.49	95.55	124.24	87.49	125.71	104.78	155.02	122.65	191.19	181.96	139.84	141.45
Pull-Ups	225.66	86.77	223.41	95.23	215.77	111.38	196.74	132.76	348.43	215.07	203.56	203.63
50-Yard Dash	14.58	14.12	17.87	19.19	21.82	30.46	47.05	149.56	160.16	102.85	161.59	73.32
Broad Jump	16.23	18.50	19.19	21.40	26.29	27.32	-	-	56.38	42.11	73.82	53.68
Softball Distance	39.50	38.00	41.54	36.97	54.25	52.80	50.28	66.38	65.02	72.97	55.70	63.33
Long Distance Run	70.07	56.38	24.89	24.62	27.65	26.83	39.48	42.86	47.54	52.90	38.24	77.86

central tendency and variation, respectively. Through various statistical analyses and under certain assumptions, one may conclude that one group is higher or lower in performance than another group. In this particular study, it has generally been found that normal subjects exceed the performance of individuals with handicapping conditions. Although the performance of individuals with handicapping conditions is generally lower than that of normal subjects, it remains important to know if the performance of individuals with handicapping conditions is invariably low, or if a certain percentage of these individuals perform above a point at which 50 percent of normal subjects perform, i.e., the normal median value. If individuals with handicapping conditions exceed median performance values, the indication is that at least median performance is within the reach of certain classes of individuals. A question related to such an analysis is whether performance above normal median performance is a function of test items or components of physical fitness. For example, individuals with handicapping conditions may exceed median levels of performance of normal subjects in flexibility but not in muscular strength/endurance. In order to shed some light on these questions, the percent of impaired subjects by sex with scores higher than median values of normal subjects was determined. The median values for normal subjects are presented in Table 3.32, and the percent of impaired subjects who surpassed the median score for normals is presented in Table 3.33.

TABLE 3.32. MEDIAN VALUES FOR NORMAL SUBJECTS ON TEST ITEMS.

Test Item	Girls	Boys
Triceps Skinfold (mm.)	13.0	11.7
Abdominal Skinfold (mm.)	11.8	10.0
Subscapular Skinfold (mm.)	10.0	9.0
Sit-Ups (no.)	35.0	41.4
Leg Raise (sec.)	28.6	34.8
Trunk Raise (sec.)	42.8	42.1
Mat Creep (sec.)	4.0	3.5
Shuttle Run (sec.)	11.4	10.6
Sit and Reach (cm.)	31.4	25.1
Right Grip (kg.)	22.0	28.7
Left Grip (kg.)	19.4	24.6
Arm Hang (sec.)	5.5	14.9
Pull-Ups (no.)	0.2	3.3
50-Yard Dash (sec.)	8.3	7.6
Broad Jump (in.)	60.4	69.0
Softball Distance (ft.)	62.5	114.9
Long Distance Run (yds./min.)	164.7	206.0

Although the information presented is relatively straight forward, a few points need to be made relative to Table 3.33. First, the information presented in the table does not consider modifications in test administration or specific influences of disabilities. Thus, for example, when individuals with visual impairments are compared with normal individuals in the 50-yard dash, no distinction is made as to whether individuals with visual impairments used

TABLE 3.33. PERCENT OF IMPAIRED SUBJECTS CATEGORIZED BY SEX WITH SCORES HIGHER THAN MEDIAN VALUES OF NORMAL SUBJECTS.*

Test Item	Auditory Impairments		Visual Impairments		Cerebral Palsy		Spinal Neuromuscular		Congenital Anomalies/ Amputees	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Triceps Skinfold	65.5	42.1	58.1	46.1	47.2	37.1	61.6	62.5	72.0	40.0
Abdominal Skinfold	69.8	55.5	53.3	56.5	52.3	44.8	57.1	78.1	73.1	44.4
Subscapular Skinfold	75.8	54.5	66.0	55.5	49.7	45.9	52.8	71.6	80.8	50.0
Sit-Ups	34.4	27.6	28.4	28.1	1.5	0.6	-	-	0.0	4.6
Leg Raise	39.0	47.7	31.3	36.9	5.4	4.5	-	-	22.2	13.6
Trunk Raise	40.2	43.3	29.8	30.6	17.0	4.4	-	-	9.1	14.3
Mat Creep**	55.5	57.3	77.6	78.0	100.0	100.0	-	-	76.5	90.0
Shuttle Run**	59.9	50.8	86.2	79.7	99.2	99.4	100.0	100.0	100.0	100.0
Sit and Reach	31.2	47.9	33.6	48.9	13.2	23.2	-	-	25.0	34.8
Right Grip	49.7	54.4	26.7	40.0	10.2	12.3	16.4	32.4	23.8	27.6
Left Grip	54.5	60.4	30.5	41.1	19.4	15.1	19.4	36.2	23.8	33.3
Arm Hang	42.7	48.3	37.8	35.6	5.7	7.4	21.1	17.9	38.9	15.4
Pull-Ups	33.1	50.2	29.6	38.5	2.2	11.6	32.1	23.6	31.6	11.1
50-Yard Dash**	51.6	43.1	73.5	70.3	98.4	99.3	100.0	100.0	100.0	100.0
Broad Jump	39.8	52.5	26.0	34.0	0.0	1.4	-	-	0.0	9.5
Softball Distance	51.5	50.9	18.9	16.3	1.4	1.2	0.0	0.0	5.0	6.7
Long Distance Run	41.0	45.1	31.3	25.3	1.7	1.1	0.0	0.0	8.3	7.1

*The information presented herein does not consider modifications in procedures followed, in certain instances, in test administration. Subjects performing activities in wheelchairs or using other assistive devices, for example, are compared with subjects following unmodified procedures.

**Because lower raw scores reflect better performance in the 50-yard dash, mat creep, and shuttle run, the percentages presented above relative to these items indicate the percentage of subjects who scored above the median point relative to raw score but below the median performance level.

guide wires, partners, or other assistive devices and no distinction is made between the blind and partially sighted. Obviously, these factors will influence results. The information in Table 3.33 presents global comparisons.

In analyzing the information in Table 3.33, it must be stressed that lower raw scores reflect better performance in the 50-yard dash, mat creep, and shuttle run. This being the case, the percentages presented in the table relative to these items indicate the percentage of subjects who scored above the median point relative to raw score but below the median performance level. Thus, 73.5 percent of visually impaired females scored above the median point on the 50-yard dash, which means that the greatest percentage of females who performed better in the 50-yard dash than normal females is 26.5 percent. In the case of skinfold measures, caution also needs to apply, since low scores on skinfolds may denote superior performance. Extreme positive or negative scores in relationship to skinfolds are undesirable.

In reviewing the information in Table 3.33, it can be seen that individuals with auditory impairments very frequently exceed the median performance of normal subjects. Over 50 percent of auditory impaired males exceed the median value of normal males in right grip, left grip, pull-ups, broad jump, and softball throw for distance. In addition, auditory impaired males compare favorably with normal males in triceps skinfold. Females with auditory impairments, on the other hand, compare quite favorably with normal females on left grip strength and softball throw for distance. A relatively small percentage of individuals with auditory impairments exceeds median performance levels of normal subjects on sit-ups.

Although many individuals with visual impairments exceed median performance values of normal subjects, individuals with visual impairments, as a group, do not exceed the median performance values of normal subjects to as great an extent as do individuals with auditory impairments. Among the areas in which male individuals with visual impairments compare most favorably are in skinfold measurements, grip strength, and sit and reach. Females with visual impairments compare most favorably with normal individuals in skinfold, leg raise, arm hang, sit and reach, and the long distance run. The poorest performance of males with visual impairments, in comparison with normal males, occurred in softball throw for distance, long distance run, sit-ups, mat creep, and shuttle run. The poorest performances of females with visual impairments, in comparison with normal females, occurred on shuttle run, mat creep, 50-yard dash, softball distance, broad jump, right grip strength, and sit-ups.

Individuals with orthopedic impairments clearly exceed the performance of normal individuals less often than do individuals from other groups of handicapping conditions. Relative to individuals with cerebral palsy, few exceed median performance levels of normal individuals in measures of muscular strength/endurance and cardiorespiratory endurance. Individuals with cerebral palsy compared most favorably with normal youngsters in skinfold measurements. Individuals with spinal neuromuscular conditions exceed the median level performance of normal individuals, to a greater extent, in the area of muscular strength/endurance than do individuals with cerebral palsy. However, in the areas related to softball throw for distance and test items involving the requirement to move a wheelchair for time, few individuals with spinal neuromuscular conditions exceed median values of normal subjects. Relative to

individuals with spinal neuromuscular conditions, most youngsters who exceed median level performance of normal subjects do so in the area of skinfold measurements. Male individuals with congenital anomalies/amputations compare most favorably with skinfold measures of normal males. In addition, males with congenital anomalies/amputations compare best with normal males in grip strength and sit and reach. Males with congenital anomalies/amputations compare least favorably with normal males in sit-ups, broad jump, softball throw for distance, dashes, mat creep, shuttle run, and long distance events. The relatively low values associated with "running" events were undoubtedly affected by the different procedures that were followed by these subjects in performing these activities. In other words, differences were undoubtedly due to differences in procedures as well as differences in fitness. Female subjects with congenital anomalies/amputations compared best with normal females in arm hang and pull-ups. Females with congenital anomalies/amputations scored lowest relative to normal females in sit-ups, trunk raise, broad jump, softball throw for distance, long distance run, stork stand, dashes, rise-to-stand, and shuttle run.

In summary, individuals with auditory impairments compare most favorably relative to median performance levels of normal subjects. A reasonable percentage of individuals with visual impairments exceed normal median performance, except in activities involving speed of movement through space. Individuals who exhibit orthopedic impairments generally compare most favorably in items dealing with skinfold measurements. Comparisons of individuals with orthopedic impairments with normal individuals is limited because of modifications in test items. Within the limitations of such comparisons, individuals with orthopedic impairments do not score well relative to normal individuals.

CHAPTER IV

FACTOR STRUCTURE OF THE NORMAL AND IMPAIRED SUBJECT GROUPS

A number of factor analytic solutions were calculated from data on the normal and impaired subject groups. Factor structures were obtained for normal boys and girls, auditory impaired boys and girls, visually impaired boys and girls, cerebral palsied boys and girls, and paraplegic wheelchair spinal neuromuscular subjects (sexes combined). The procedures utilized and the results obtained from these analyses are discussed in this chapter.

Factor Analytic Procedures

The factor analytic techniques used were those proposed by Harris and Harris (1971) and employed by Rarick and Dobbins (1975) in a study similar to the present one. In this procedure, six factor solutions are derived using three types of factor analysis: incomplete principal components analysis (Harmon, 1967), canonical component analysis (Rao, 1955), and alpha factor analysis (Kaiser and Caffrey, 1965); and two types of rotation: orthogonal and oblique. The type of orthogonal rotation used was the varimax procedure developed by Kaiser (1958), and the type of oblique rotation used was developed by Harris and Kaiser (1964). The six solutions were calculated using the default option procedures of subprogram Factor in the Statistical Package for the Social Sciences (Nie, et al., 1975). A variable was considered to belong to a factor if it had a factor loading of .40 or greater on four of the six derived solutions. This procedure was considered to constitute a conservative approach to factor analysis where the final factor structure is not overly dependent on the type of factor analysis employed.

Factors which emerged from this procedure were classified as either comparable common factors or comparable specific factors as defined by Dobbins and Rarick (1975). In this definition, a comparable common factor is one which has at least three variables which load at .40 or better on four out of the six derived solutions. A comparable specific factor is defined as one which has one or two variables which load at .40 or better on four out of the six derived solutions.

Since the final factor structure is directly dependent upon the number and type of variables included in the analysis, some care was taken to include only those items which had demonstrated good reliability. In addition, variables which had been computed from other variables (e.g., sum of the skinfolds, sum of the grips, softball throw for velocity) were not entered into the factor analysis. It also should be noted that the factor analyses performed on the data for orthopedically impaired subjects were calculated with different sets of variables than those performed on data from the normal and the sensory impaired groups. This was necessary because, as discussed earlier, some test items were deemed inappropriate for certain orthopedic disabilities. Table 4.1 presents the variables included in the factor analysis for each group of subjects. An "X" is placed next to those variables included in the factor analysis for each group of subjects.

TABLE 4.1. TEST SCORES INCLUDED IN FACTOR ANALYSIS CATEGORIZED BY GROUP.

Test Items	Normal	Auditory	Visual	Cerebral Palsy	Paraplegic Wheelchair Spinal Neuromuscular
Triceps Skinfold	X	X	X	X	X
Abdominal Skinfold	X	X	X	X	X
Subscapular Skinfold	X	X	X	X	X
Sit-Ups	X	X	X	X	
Leg Raise	X	X	X	X	
Trunk Raise	X	X	X		
Mat Creep	X	X	X	X	
Shuttle Run	X	X	X	X	X
Sit and Reach	X	X	X		
Right Grip	X	X	X	X	X
Left Grip	X	X	X	X	X
Arm Hang	X	X	X	X	X
Pull-Ups	X	X	X	X	X
50-Yard Dash	X	X	X	X	X
Standing Broad Jump	X	X	X		
Softball Distance	X	X	X	X	X
Long Distance Run (Yards per Minute)	X	X	X	X	X

Seventeen test items were factor analyzed for the normal, auditory impaired, and visually impaired subject groups. Fourteen items were factor analyzed from cerebral palsied subjects, and 11 were factor analyzed for paraplegic wheelchair spinal neuromuscular participants. Only subjects who took all the items listed under the appropriate group in Table 4.1 were included in the factor analysis. Since many subjects had missing data for a variety of reasons, the number of subjects entered in the factor analysis was considerably less than the number of subjects tested as part of the entire study. Table 4.2 presents a breakdown of the number of subjects entered into the factor analysis by group membership and sex.

TABLE 4.2. NUMBER OF SUBJECTS IN THE FACTOR ANALYSIS CATEGORIZED BY GROUP AND SEX.

	Boys	Girls	Uncategorized
Normal	209	336	-
Auditory Impaired	491	385	-
Visually Impaired	244	167	-
Cerebral Palsy	55	42	-
Paraplegic Wheelchair	-	-	61

An attempt was made to interpret the extracted factors including the assignment of factor names; however, the reader is cautioned as to the subjective nature of this task. To help identify, interpret, and label extracted factors, the time-duration classification schema presented by Edington and Edgerton (1976) pertaining to strength, power, and endurance was consulted and modified for this study. In essence, test items characterized by maximum or near maximum effort of an activity and/or which were performed in zero to one second were labeled as strength. A power label was applied to those factors in which average performance was performed from one second to two minutes. The emergence of three power items necessitated a further distinction. A power-speed label was applied to factors characterized by the predominance of movement for the purpose of speed and moderate load involvement. A power-strength label was applied to a power factor in which the continued exertion of a relatively high load predominated. Since these power items were associated with a 30-second interval, they required near maximum contraction. A power-endurance label was applied to power factors performed within a 30-second to two-minute interval. These items were characterized by lighter load. In cases in which there was an overlapping of time duration, factors were designated in terms of the closest factor.

While this model was convenient for interpreting and classifying activities which require muscular strength/endurance, it was not sufficient to interpret all Project UNIQUE test items. The skinfold measures and the sit and reach test had no applicability to this model. The long distance run, although expressed in terms of yards per minute, was not rated in terms of the model because it was conceptualized and generally characterized as a submaximal cardiorespiratory endurance activity rather than a strength/endurance factor. Factors which included these variables, therefore, were interpreted exclusive of this system. They were interpreted, instead, in terms of generally accepted notions of body composition, flexibility, and cardiorespiratory endurance.

The cerebral palsied subjects included in the factor analysis had NASCP classifications of VA or higher in order not to unduly restrict test items selected. Only ambulatory cerebral palsied subjects were, thus, entered into the analysis. In view of small subject numbers and/or not to unduly restrict test items selected, only subjects categorized as paraplegic wheelchair of the spinal neuromuscular group were included in the factor analysis.

The factor loadings presented in the factor structure tables in the following section have been rounded to two places, and the minus signs for speed variables have been dropped.

When a negative factor loading appears in the tables, it is due to the fact that that variable is at the opposite end of the continuum when contrasted to the other variables which load on that factor.

Results of the Factor Analyses

Factor structures were obtained on both raw score and residual (age controlled) intercorrelation matrices. Both structures are presented for each subject group. For those structures obtained from the raw score matrices, no attempt was made to control for possible differences in factor structure due to age. Extracting a factor structure from the residual matrices represented

an effort to statistically control the effects of age. Factor analyses on residual correlation matrices have been reported previously in the physical education literature (Jackson and Frankiewicz, 1975; Rarick and Dobbins, 1975). An advantage to controlling for age is that it partials out the effects of a variable which may be strongly related to fitness test performance, in general, and therefore may yield a more resolute factor structure. A disadvantage of controlling for age is that the resulting factor structure may be somewhat artificial because it was not based on the actual scores obtained by subjects. In the following discussion of factor structures, the structure obtained from the raw score intercorrelation matrix is presented first, and the structure obtained from the residual intercorrelation matrix is reported second for each group of subjects.

Factor Structure of the Normal Girls

The results of the factor analyses calculated from the raw score intercorrelation matrix for the normal girls are presented in Table 4.3.

TABLE 4.3. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR NORMAL GIRLS.

	Orthogonal Solutions			Oblique Solutions		
Factors	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Triceps Skinfold	.88	.87	.90	.88	.88	.90
Abdominal Skinfold	.88	.87	.88	.90	.90	.91
Subscapular Skinfold	.84	.86	.83	.88	.88	.86
Factor 2						
Shuttle Run	.73	.71	.74	.78	.77	.79
50-Yard Dash	.72	.73	.72	.78	.78	.78
Broad Jump	.57	.60	.55	.71	.72	.70
Sit-Ups	.53	.51	.54	.64	.63	.65
Mat Creep	.48	.48	.47	.56	.56	.56
Factor 3						
Right Grip	.93	.90	.93	.96	.94	.96
Left Grip	.87	.89	.87	.92	.93	.92
Softball Distance	.43	.43	.43	.50	.50	.50
Factor 4						
Trunk Raise	.51	.53	.49	.57	.60	.56
Sit and Reach	.49	.47	.49	.53	.51	.53
Leg Raise	.46	-	.48	.53	.47	.55
Factor 5						
Arm Hang	.66	.68	.67	.73	.75	.74
Pull-Ups	.57	.57	.55	.59	.59	.58

Five factors--four comparable common and one comparable specific--were extracted from the raw score matrix for normal girls. Factor 1 is represented by the three skinfold measures and, therefore, appears to be a body composition factor. Factor 2 consists of muscular strength/endurance items which require power. Speed of movement and coordination appear to characterize performance in this factor. Factor 2 appears to be a power-speed factor. The grip strength measures and the softball throw (distance) constitute Factor 3. Factor 3 is characterized by maximal, non-repetitive effort and, thus, seems to be predominantly a strength factor. Factor 4 is characterized by low back and hip region involvement of the body, flexibility, and a submaximal sustained effort. Factor 4 may have emerged because normal girls who did well on the two measures of strength/endurance (especially trunk raise) did so because of greater flexibility which allowed for greater mechanical advantage. Applying this logic, Factor 4 might be considered a trunk/hip flexibility/power-endurance factor. Factor 5 is a comparable specific factor characterized by the arm hang and pull-up tests. Naming specific factors is especially hazardous, but arm/shoulder power-strength is offered as a tentative label. The five comparable factors which were extracted from the raw score intercorrelation matrix for normal girls accounted for 68.1 percent of the total variance of the 17 test items.

The results of the factor analyses performed on the residual intercorrelation matrix for the normal girls are presented in Table 4.4.

TABLE 4.4. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR NORMAL GIRLS.

	Orthogonal Solutions			Oblique Solutions		
Factors	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.89	.88	.89	.91	.90	.92
Triceps Skinfold	.89	.88	.89	.88	.87	.89
Subscapular Skinfold	.84	.86	.82	.86	.89	.86
Factor 2						
Shuttle Run	.74	.76	.40	.76	.78	.56
50-Yard Dash	.66	.71	-	.72	.75	.48
Broad Jump	.59	.61	-	.69	.71	.47
Sit-Ups	.59	.56	-	.66	.65	.51
Long Distance Run (Yards per Minute)	.49	.44	-	.55	.52	.51
Mat Creep	.48	.48	-	.56	.57	.43
Factor 3						
Right Grip	.95	.91	.89	.97	.93	.88
Left Grip	.85	.89	.81	.88	.92	.82
Softball Distance	-	-	.42	.41	.43	.46
Mat Creep	-	-	.45	.41	.43	.50
Factor 4						
Arm Hang	.67	.63	.71	.74	.71	.74
Pull-Ups	.56	.59	.46	.59	.61	.48
Sit-Ups	-	-	.54	.50	.51	.63
Broad Jump	-	-	.51	.46	.45	.61

Four comparable common factors were extracted from the residual intercorrelation matrix. Factor 1 contains the three skinfold measures and, consequently, appears to be a body composition factor. Factor 2 appears to be a strength/endurance factor emphasizing a power-speed dimension. Factor 3 is comprised of the grip strength measures, the softball throw, and the mat creep. Factor 3 appears to be a muscular strength/endurance factor in which maximum or near maximal effort predominates. Thus, Factor 3 is identified as a strength factor. Factor 4 consists of the flexed arm hang, pull-ups, sit-ups, and standing broad jump, and could be considered to be a power-strength factor with less emphasis on strength than Factor 3 and less emphasis on speed than Factor 2. Thus, Factor 4 may be conceived as a power-strength factor. The four comparable common factors derived from the residual intercorrelation matrix for normal girls accounted for 61.7 percent of the total variance of the 17 test items.

The factor structures obtained from the raw score and residual intercorrelation matrices for the normal girls appear similar but not identical. Factor 1 (body composition), Factor 2 (power-speed), and Factor 3 (strength) seem to be fairly consistent across the two structures. The existence of raw score Factor 4 (trunk/hip flexibility/power-endurance) is not supported by the residual structure. A factor containing the arm hang and pull-ups would seem to be supported as a power-strength factor, although it is not clear whether it should be considered a comparable common or a comparable specific factor for normal girls.

Factor Structure of the Normal Boys

The results of the factor analyses calculated on the raw score data for the normal boys are presented in Table 4.5.

Three comparable common factors were extracted from the raw score intercorrelation matrix for normal boys. Factor 1 consists of the three skinfold measures and the flexed arm hang variable. The arm hang variable has a negative loading, indicating a negative relationship with the skinfolds. This would seem to support, at least for normal boys, the criticism that the arm hang test is biased against participants with greater amounts of body fat. Factor 1 appears to be a body composition factor. Factor 2 is comprised of a large number of items and might best be described as a general power factor, although the variables with the highest loadings are similar to the variables that load on Factor 2 for the normal girls and described as power-speed. Factor 3 is predominated by the grip strengths, although it should be noted that in the alpha solutions, the grips loaded higher on Factor 2. The strength label seems appropriate for Factor 3. The three comparable factors which were extracted from the raw score intercorrelation matrix for normal boys accounted for 64.0 percent of the total variance of the 17 test items.

The results of the factor analyses obtained on the residual intercorrelation matrix for normal boys are presented in Table 4.6.

Four factors--three comparable common and one comparable specific--were extracted from the residual intercorrelation matrix for normal boys. Factor 1 is predominated by the skinfold measures and appears to be a body composition factor. As with the raw score factor structure for normal boys, flexed arm

TABLE 4.5. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR NORMAL BOYS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.91	.90	.92	.90	.88	.91
Subscapular Skinfold	.86	.88	.87	.87	.87	.88
Triceps Skinfold	.81	.83	.77	.83	.86	.79
Arm Hang	-.45	-.46	-.42	-.51	-.53	-.49
Factor 2						
Shuttle Run	.70	.81	.78	.82	.87	.83
Mat Creep	.68	.71	.53	.71	.71	.58
50-Yard Dash	.65	.81	.89	.83	.90	.91
Sit-Ups	.64	.65	.60	.74	.71	.67
Softball Distance	.48	.64	.77	.63	.71	.77
Long Distance Run (Yards per Minute)	.47	.50	.53	.62	.60	.60
Pull-Ups	.46	.49	.60	.64	.62	.66
Leg Raise	.45	-	-	.49	.43	.41
Arm Hang	.43	-	-	.56	.46	.46
Broad Jump	.42	.63	.79	.64	.75	.80
Right Grip	-	.44	.82	.53	.63	.81
Left Grip	-	.43	.83	.52	.63	.82
Factor 3						
Left Grip	.93	.87	-	.96	.97	-
Right Grip	.91	.86	-	.95	.97	-
Broad Jump	.65	.46	-	.74	.45	-
Softball Distance	.59	.42	-	.70	.65	-
Shuttle Run	.48	-	-	.65	.61	.46
Pull-Ups	.44	-	-	.54	.52	.44

TABLE 4.6. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR NORMAL BOYS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.90	.87	.93	.92	.89	.93
Subscapular Skinfold	.83	.85	.83	.88	.89	.86
Triceps Skinfold	.81	.83	.79	.84	.86	.81
Arm Hang	-	-	-.47	-.49	-.45	-.56
Factor 2						
50-Yard Dash	.83	.80	.85	.87	.86	.89
Shuttle Run	.76	.77	.75	.81	.82	.80
Mat Creep	.70	.70	.69	.72	.73	.71
Sit-Ups	.56	.56	.56	.65	.65	.64
Softball Distance	.51	.52	.53	.54	.54	.55
Broad Jump	.51	.50	.50	.57	.57	.57
Factor 3						
Left Grip	.97	.91	1.00	1.00	.95	1.02
Right Grip	.86	.90	.79	.90	.94	.83
Factor 4						
Sit-Ups	.60	.48	-	.45	.46	-
Arm Hang	.59	.73	.43	.68	.81	.54
Pull-Ups	.41	.54	-	.51	.64	-

hang loads at the opposite end of the continuum. Factor 2 is characterized by speed, coordination, and strength and, thus, contains items which place a premium on power-speed. Factor 3 is a comparable specific factor consisting solely of the grip strength measures and is labeled as a strength factor. The variables in Factor 4 seem to require a lesser degree of strength than Factor 3 but greater strength and lesser speed than Factor 2. Thus, Factor 4 might be appropriately labeled a power-strength factor. The four factors which emerge from the residual matrix account for 62.8 percent of the total variance of the 17 test items.

The factor structures obtained from the raw score and residual inter-correlation matrices for the normal boys appear to confirm the fact that, at least for this group of subjects, age operated as a variable which contributed to the production of an artificially large general factor. The factor structure resolution from the residual matrix is much clearer than that obtained from the raw score matrix which appears to yield at least one exaggerated common factor (Factor 2). There remain, however, similarities between the two structures. Factor 1 (body composition) is virtually identical for both structures. Although Factor 2 in the raw score structure is confused by the apparent generalizing effect of age, the variables which tend to have the highest loadings are similar to the variables which constitute Factor 2 (power-speed) in the residual structure. The residual matrix appears to separate power items emphasizing strength and speed. The grip strength measures appear to comprise a factor for normal boys, but it is unclear whether that factor should be considered a comparable common or a comparable specific factor. Factor 4 (power-strength) was not supported by both structures. The variables which constitute Factor 4 may have been subsumed as part of the general Factor 2 in the raw score factor structure.

Factor Structure of the Auditory Impaired Girls

The results of the factor analyses extracted for the raw score inter-correlation matrix for auditory impaired girls are presented in Table 4.7.

Five comparable common factors emerged from the raw score matrix of the auditory impaired girls. Factor 1 is comprised of the skinfold measures and appears to be a body composition factor. Factor 2 consists of variables exhibiting a speed/force/coordination relationship. It appears to be a power-speed factor. Factor 3 is comprised of variables which require a single maximal effort on behalf of the participant. Factor 3 seems to be a strength factor. The measures contained in Factor 4 all involve the action of the low back and/or lower extremities. Since measures of power-endurance and flexibility load on Factor 4, the label of trunk/hip flexibility/power-endurance seems logical. Factor 5 is more difficult to describe. However, since it consists of the arm hang and pull-ups and emphasizes high load to a greater extent than Factor 2, it is logically considered a power-strength factor. The fact that the long distance run appears may be due to the strength/endurance relationship required by test items, i.e., the endurance element required in arm hang and the strength/power element required in the long distance run. Thus, Factor 5 might be labeled as power-strength factor. The five extracted factors accounted for 70.9 percent of the total variance of the 17 test items for auditory impaired girls.

TABLE 4.7. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR AUDITORY IMPAIRED GIRLS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.87	.88	.87	.88	.89	.88
Subscapular Skinfold	.86	.86	.86	.88	.88	.88
Triceps Skinfold	.82	.82	.82	.82	.82	.82
Factor 2						
Shuttle Run	.82	.82	.81	.86	.86	.86
Mat Creep	.77	.78	.76	.82	.83	.82
50-Yard Dash	.69	.69	.70	.79	.79	.79
Factor 3						
Right Grip	.94	.94	.91	.95	.95	.92
Left Grip	.91	.93	.88	.93	.95	.90
Softball Distance	.58	.55	.62	.62	.59	.66
Broad Jump	.49	.45	.52	.56	.53	.59
Factor 4						
Sit and Reach	.55	.58	.52	.59	.61	.57
Sit-Ups	.54	.55	.53	.67	.67	.66
Leg Raise	.50	.46	.52	.56	.52	.58
Trunk Raise	.47	.44	.49	.49	.46	.51
Broad Jump	.43	.48	-	.58	.62	.54
Factor 5						
Arm Hang	.79	.78	.79	.83	.83	.83
Pull-Ups	.59	.59	.57	.60	.61	.59
Long Distance Run (Yards per Minute)	.46	.45	.46	.52	.52	.52

The factor structure derived from the residual intercorrelation matrix of the auditory impaired girls is presented in Table 4.8.

TABLE 4.8. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR AUDITORY IMPAIRED GIRLS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.87	.87	.87	.88	.88	.88
Subscapular Skinfold	.85	.85	.85	.87	.88	.87
Triceps Skinfold	.81	.81	.81	.81	.81	.82
Factor 2						
Shuttle Run	.82	.82	.82	.85	.85	.85
Mat Creep	.77	.77	.77	.82	.83	.82
50-Yard Dash	.69	.68	.70	.78	.78	.79
Factor 3						
Right Grip	.94	.94	.90	.95	.95	.91
Left Grip	.91	.93	.87	.92	.95	.89
Softball Distance	.55	.51	.59	.58	.55	.61
Broad Jump	.45	.41	.49	.51	.48	.55
Factor 4						
Sit and Reach	.54	.55	.51	.57	.58	.55
Sit-Ups	.54	.55	.52	.66	.67	.65
Leg Raise	.47	.44	.49	.52	.49	.55
Trunk Raise	.46	.42	.48	.48	.45	.50
Broad Jump	.42	.46	-	.55	.58	.51
Factor 5						
Arm Hang	.79	.78	.79	.83	.83	.83
Pull-Ups	.58	.59	.57	.60	.61	.59
Long Distance Run	.46	.45	.47	.53	.53	.53

Five comparable common factors were extracted from the residual intercorrelation matrix of the auditory impaired girls. Factor 1 contains the three skinfold measures and may be considered a body composition factor. Factor 2 consists of variables which place a premium on speed of movement. Factor 2 appears to be a power-speed factor. The items which comprise Factor 3 require a single maximal effort for successful execution and appears to reflect a strength factor. Factor 4 consists of measures of power-endurance, as well as a measure of flexibility, which involves the lower trunk and/or hip region. Trunk/hip flexibility/power-endurance would seem to be a logical label for Factor 4. Using the same logic as presented in connection with the raw score matrix, Factor 5 is tentatively labeled as a power-strength factor. The five factors derived from the residual matrix for the auditory impaired girls accounted for 69.7 percent of the total variance of the 17 test items.

The factor structures obtained from the raw score and residual score intercorrelation matrix for the auditory impaired girls are virtually identical. Unlike the group of normal boys, which is apparently influenced by the generalizing effect of age, no such influence appears for the auditory impaired girls. The existence of all five factors is supported by their presence on both factor structures.

Factor Structure of the Auditory Impaired Boys

The results of the factor analyses obtained from the raw score matrix for auditory impaired boys is presented in Table 4.9.

TABLE 4.9. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR AUDITORY IMPAIRED BOYS.

	Orthogonal Solutions			Oblique Solutions		
Factors	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.92	.91	.91	.92	.92	.91
Subscapular Skinfold	.86	.87	.86	.87	.88	.87
Triceps Skinfold	.82	.83	.81	.82	.83	.81
Factor 2						
Shuttle Run	.83	.83	.81	.91	.91	.89
Mat Creep	.80	.81	.80	.83	.83	.83
50-Yard Dash	.72	.73	.72	.85	.85	.84
Factor 3						
Right Grip	.91	.90	.84	.94	.96	.87
Left Grip	.87	.90	.79	.90	.95	.82
Broad Jump	.68	.59	.78	.79	.73	.85
Softball Distance	.64	.56	.68	.71	.67	.74
50-Yard Dash	.44	-	.49	.60	.57	.63
Pull-Ups	.41	-	.56	.51	.45	.61
Factor 4						
Arm Hang	.68	.73	.58	.72	.75	.65
Leg Raise	.58	.54	.59	.61	.57	.63
Sit-Ups	.54	.52	.53	.63	.61	.62
Pull-Ups	.46	.59	-	.56	.66	.41
Long Distance Run (Yards per Minute)	.44	.47	-	.52	.54	.45
Broad Jump	-	.50	-	.56	.65	.46

Four comparable common factors emerged from the raw score intercorrelation matrix of the auditory impaired boys. Factor 1 is represented by the three skinfold measures. Factor 1 appears to be a body composition factor. Factor 2 consists of measures which place an emphasis on a force/time/coordination dimension and might be termed a power-speed factor. A strength factor appears to dominate Factor 3. Factor 4 consists of a rather diverse group of variables

reflecting high power or strength and power-endurance factors. Due to the predominance of the arm hang, this factor is viewed tentatively as a power-strength factor. The four factors extracted from the raw data matrix of the auditory impaired boys accounted for 67.4 percent of the total variance of the 17 test items.

The results of the factor analyses performed on the residual inter-correlation matrix for the auditory impaired boys is presented in Table 4.10.

TABLE 4.10. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR AUDITORY IMPAIRED BOYS.

Factors	Orthogonal Solutions			Oblique Solutions		
	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.90	.90	.87	.92	.92	.89
Subscapular Skinfold	.85	.86	.82	.88	.89	.85
Triceps Skinfold	.84	.83	.85	.84	.83	.84
Factor 2						
Shuttle Run	.85	.85	.84	.88	.88	.88
Mat Creep	.79	.80	.79	.81	.82	.81
50-Yard Dash	.79	.79	.80	.84	.83	.85
Factor 3						
Right Grip	.93	.91	.86	.94	.93	.88
Left Grip	.85	.90	.77	.86	.91	.80
Softball Distance	.43	-	.50	.49	.45	.54
Broad Jump	.42	-	.49	.51	.47	.55
Factor 4						
Trunk Raise	.61	.63	.54	.61	.63	.54
Sit-Ups	.49	.45	.54	.57	.55	.62
Leg Raise	.43	-	.48	.49	.47	.53
Factor 5						
Pull-Ups	.73	.74	.59	.77	.76	.66
Arm Hang	.59	.62	.57	.67	.68	.66

Four comparable common and one comparable specific factor emerged from the residual intercorrelation matrix for the auditory impaired boys. Factor 1 is characterized by the skinfold measures and appears to be a body composition factor. Factor 2 consists of three variables which are associated with power-speed. Factor 3 is comprised of measures which require one short maximum effort for successful execution. Factor 3 might be appropriately labeled a strength factor. Factor 4 contains three power-endurance variables which involve the low trunk or hip areas. Factor 4 might be a trunk/hip power-endurance factor. Factor 5 is a comparable specific factor defined by the pull-ups and flexed arm hang tests. Although labeling a specific factor is especially hazardous, Factor 5 might be tentatively viewed as an arm/shoulder power-strength factor. The five factors extracted from the residual

intercorrelation matrix for the auditory impaired boys accounted for 67.9 percent of the total variance of the 17 test items.

The residual intercorrelation matrix appears to yield a more resolute factor structure than the raw score matrix for the auditory impaired boys. One additional factor emerged from the residual matrix. In essence, the residual matrix separated power-strength factors from the power-endurance factors found in the raw score matrix. The existence of the three remaining factors (body composition, power-speed, and strength) is supported by virtue of their extraction from both matrices.

Factor Structure of the Visually Impaired Girls

The results of the factor analyses obtained on the raw score matrix for visually impaired girls is presented in Table 4.11.

TABLE 4.11. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR VISUALLY IMPAIRED GIRLS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.88	.88	.87	.89	.90	.89
Subscapular Skinfold	.87	.87	.86	.88	.88	.88
Triceps Skinfold	.86	.86	.86	.87	.87	.86
Factor 2						
50-Yard Dash	.77	.78	.76	.81	.83	.80
Broad Jump	.73	.73	.71	.79	.80	.78
Softball Distance	.62	.67	.57	.64	.69	.60
Shuttle Run	.55	.53	.56	.54	.52	.55
Mat Creep	.54	.54	.52	.58	.60	.57
Long Distance Run (Yards per Minute)	.50	.46	.53	.53	.50	.55
Sit-Ups	.48	.46	.48	.53	.52	.53
Factor 3						
Right Grip	.85	.84	.82	.94	.94	.91
Left Grip	.84	.84	.84	.93	.94	.92
Broad Jump	-	-	.42	.60	.59	.63
Factor 4						
Leg Raise	.70	.63	.72	.72	.65	.74
Trunk Raise	.62	.67	.64	.65	.69	.67
Sit and Reach	.47	.44	.47	.52	.49	.52
Factor 5						
Pull-Ups	.79	.79	.75	.80	.80	.76
Arm Hang	-	-	.40	.50	.51	.50

Five factors--four comparable common and one comparable specific--emerged from the raw score intercorrelation matrix of the visually impaired girls. Factor 1 consists of the three skinfold measures and appears to be a body composition factor. Factor 2 is characterized by items which possess a force/time/coordination dimension and might be appropriately labeled a power-speed factor. Factor 3 contains the grip strength measures and the standing broad jump test. It appears to be a strength factor. Factor 4 consists of two power-endurance items and one flexibility item which involve the lower back and/or hip region. Factor 4 might be considered a trunk/hip flexibility/power-endurance factor. Factor 5 is a comparable specific factor defined by the pull-ups and flexed arm hang test items. Factor 5 is tentatively labeled a power-strength factor. The five factors extracted from the raw data matrix of the visually impaired girls accounted for 70.0 percent of the total variance of the 17 test items.

The results of the factor analyses performed on the residual intercorrelation matrix of the visually impaired girls is presented in Table 4.12.

TABLE 4.12. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR VISUALLY IMPAIRED GIRLS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.88	.88	.87	.89	.89	.88
Subscapular Skinfold	.87	.88	.87	.89	.89	.89
Triceps Skinfold	.86	.86	.86	.86	.87	.86
Factor 2						
50-Yard Dash	.77	.77	.75	.80	.81	.79
Broad Jump	.72	.72	.70	.78	.78	.76
Softball Distance	.60	.64	.56	.62	.65	.58
Mat Creep	.58	.60	.56	.63	.65	.61
Long Distance Run (Yards per Minute)	.53	.50	.55	.56	.53	.57
Shuttle Run	.52	.50	.54	.51	.49	.53
Sit-Ups	.47	.45	.47	.51	.50	.50
Factor 3						
Right Grip	.90	.87	.84	.96	.93	.90
Left Grip	.84	.86	.85	.91	.93	.92
Factor 4						
Leg Raise	.69	.62	.70	.70	.63	.72
Trunk Raise	.61	.65	.64	.63	.66	.66
Sit and Reach						
Factor 5						
Pull-Ups	.80	.79	.74	.82	.81	.76
Arm Hang	-	.40	.43	.50	.51	.53

Three comparable common factors and two comparable specific factors were extracted from the residual intercorrelation matrix for visually impaired girls. Factor 1 contains the three skinfold items and appears to be a body composition factor. Factor 2 consists of a number of variables which are characterized by speed and appears to be a power-speed factor. Factor 3 is a comparable specific factor defined by the two grip strength measures. Factor 3 might be considered a strength factor, although as mentioned previously, naming comparable specific factors is an especially hazardous undertaking. Factor 4 is characterized by two power-endurance items and one flexibility item which involve the low back and/or hip regions of the body. Factor 4 appears to be a trunk/hip flexibility/power-endurance factor. Factor 5 is a comparable specific factor which consists of pull-ups and flexed arm hang measures. It is tentatively labeled an arm/shoulder power-strength factor. The five factors extracted from the residual intercorrelation matrix for the visually impaired girls accounted for 69.3 percent of the total variance of the 17 test items.

The factor structures obtained from the raw score intercorrelation matrix and the residual intercorrelation matrix for the visually impaired girls appear to be quite similar. In fact, the only major distinction appears to be that the standing broad jump test loads on Factor 3 for the raw score factor matrix, but does not appear with Factor 3 for the residual intercorrelation matrix factor structure. The result is that Factor 3 for the raw score factor structure is considered to be a comparable common factor, while Factor 3 for the residual matrix factor structure is interpreted as a comparable specific factor. The existence of the remaining factors is supported by their extraction from both matrices.

Factor Structure of the Visually Impaired Boys

The results of the factor analyses performed on the raw score matrix for visually impaired boys is presented in Table 4.13.

Four comparable common factors emerged from the raw score intercorrelation matrix of the visually impaired boys. Factor 1 appears to be a body composition factor, as it contains the three skinfold measures. With the exception of the grip strength measures, Factor 2 is predominated by items which place a premium on a force/speed/coordination relationship and, thus, might be considered a power-speed factor. Factor 3 is defined by the grip strength measures and the pull-up test. Factor 3 appears to be an upper limb strength factor. Variables predominating in Factor 4 appear to emphasize the exertion of maximal or near maximal effort in a relatively short time period. Factor 4 appears to be a power-strength factor. The four factors extracted from the raw data matrix of the visually impaired boys accounted for 66.4 percent of the total variance of the 17 test items.

The results of the factor analyses performed on the residual intercorrelation matrix for the visually impaired boys in presented in Table 4.14.

Three comparable common factors and one comparable specific factor emerged from the residual intercorrelation matrix of the visually impaired boys. Factor 1 consists of the three skinfold measures and appears to be a body composition factor. Factor 2 is characterized by time/speed/coordination and

TABLE 4.13. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR VISUALLY IMPAIRED BOYS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.96	.94	.95	.96	.95	.94
Subscapular Skinfold	.89	.92	.89	.90	.92	.89
Triceps Skinfold	.83	.83	.83	.86	.85	.84
Factor 2						
50-Yard Dash	.73	.72	.77	.79	.78	.82
Broad Jump	.69	.71	.72	.84	.85	.85
Softball Distance	.64	.67	.66	.73	.75	.73
Mat Creep	.58	.60	.54	.62	.63	.59
Long Distance Run (Yards per Minute)	.55	.55	.55	.69	.68	.68
Shuttle Run	.49	.48	.51	.51	.51	.52
Right Grip	-	-	.44	.56	.55	.60
Left Grip	-	-	.44	.56	.55	.61
Factor 3						
Left Grip	.85	.83	.76	.95	.96	.86
Right Grip	.82	.84	.74	.93	.96	.84
Pull-Ups	-	-	.57	.43	.41	.65
Factor 4						
Pull-Ups	.65	.74	.42	.73	.81	.56
Arm Hang	.57	.66	.42	.64	.72	.53
Sit-Ups	.56	.49	.46	.66	.62	.59
Long Distance Run (Yards per Minute)	.54	.49	.41	.68	.65	.57
Leg Raise	.50	.42	.55	.52	.45	.58

TABLE 4.14. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR VISUALLY IMPAIRED BOYS.

Factors	Orthogonal Solutions			Oblique Solutions		
	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Abdominal Skinfold	.95	.93	.93	.96	.95	.93
Subscapular Skinfold	.89	.91	.87	.90	.92	.88
Triceps Skinfold	.84	.84	.85	.87	.87	.86
Factor 2						
50-Yard Dash	.71	.69	.74	.75	.73	.77
Broad Jump	.69	.70	.69	.80	.81	.81
Softball Distance	.63	.65	.61	.67	.69	.66
Mat Creep	.62	.64	.59	.67	.68	.65
Long Distance Run (Yards per Minute)	.53	.53	.54	.66	.65	.65
Shuttle Run	.46	.45	.46	.46	.45	.46
Factor 3						
Left Grip	.91	.88	.84	.97	.94	.89
Right Grip	.84	.88	.79	.90	.94	.85
Factor 4						
Pull-Ups	.64	.73	.44	.70	.78	.54
Arm Hang	.56	.65	.43	.62	.70	.51
Sit-Ups	.54	.47	.45	.62	.59	.56
Long Distance Run (Yards per Minute)	.52	.46	.41	.64	.61	.55
Leg Raise	.47	-	.55	.47	-	.55

could be considered to be a power-speed factor. Factor 3 is a comparable specific factor defined by the two grip strength measures. It might be tentatively labeled as a strength factor. Factors predominating in Factor 4 appear to require near maximum force in a relatively short time period. The logical label for Factor 4 might be power-strength factor. The four factors extracted from the residual intercorrelation matrix for the visually impaired boys accounted for 63.6 percent of the total variance of the 17 test items.

The factor structures obtained from the raw score intercorrelation matrix and the residual intercorrelation matrix for the visually impaired boys appear to be quite similar, although the residual matrix structure may be slightly more resolute. Factor 1 (body composition), Factor 2 (power-speed), and Factor 4 (power-strength) would appear to be supported for the visually impaired boys by virtue of their emergence on both factor structures. The existence of a factor containing the grip strength measures would also seem to be supported, although it is unclear whether that factor should be considered a comparable common factor or a comparable specific factor.

Factor Structure of the Cerebral Palsied Girls

The results of the factor analyses obtained on the raw score matrix for cerebral palsied girls is presented in Table 4.15.

TABLE 4.15. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR CEREBRAL PALSIED GIRLS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Subscapular Skinfold	.91	.86	.93	.92	.86	.94
Triceps Skinfold	.91	.93	.90	.91	.93	.90
Abdominal Skinfold	.89	.91	.89	.91	.92	.90
Mat Creep	-.47	-.46	-.46	-.51	-.47	-.50
Factor 2						
Shuttle Run	.92	.85	.90	.98	.90	.96
Mat Creep	.55	.61	.52	.61	.66	.58
50-Yard Dash	.53	.52	.60	.56	.54	.62
Factor 3						
Right Grip	.89	.83	1.00	.91	.85	1.02
Left Grip	.85	.92	.75	.86	.92	.76
Factor 4						
Pull-Ups	.73	-	.73	.73	-	.73
Softball Distance	.64	-	.65	.69	-	.69
Arm Hang	.54	-	.55	.59	-	.58
Factor 5						
Long Distance Run (Yards per Minute)	.93	.82	.96	.95	.85	.99
Sit-Ups	.56	.65	.52	.61	.67	.58

Three comparable common factors and two comparable specific factors were extracted from the raw score matrix for cerebral palsied girls. Factor 1 consists of the three skinfold measures and the mat creep item. As indicated by the negative loading, cerebral palsied girls with large skinfolds had greater difficulty with the mat creep test. Factor 1 appears to be a body composition factor. Factor 2 consists of three measures which place a premium on the exertion of submaximal force in time. However, unlike previously discussed groups, scores on the shuttle run and dashes exceed 30 seconds. Thus, Factor 2 appears to be a power-endurance factor. Factor 3 is a comparable specific factor defined by the grip strength measures. Factor 3 might be tentatively labeled a strength factor. Factor 4 is comprised of three variables which involve the arm and shoulder musculature and which are characterized by the exertion of maximal or near maximal effort in a relatively short time period. Factor 4 appears to be an arm/shoulder power-strength factor. Factor 5 is a comparable specific factor consisting of the long distance run and the sit-ups. In view of its sustaining characteristics, Factor 5 might be tentatively labeled a power-endurance factor. It is distinguished from Factor 2 in that more emphasis on endurance is placed on Factor 5. The five factors extracted from the raw score matrix for cerebral palsied girls accounted for 77.2 percent of the total variance of the 14 test items.

The results of the factor analyses performed on the residual inter-correlation matrix for the cerebral palsied girls is presented in Table 4.16.

TABLE 4.16. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR CEREBRAL PALSIED GIRLS.

Factors	Orthogonal Solutions			Oblique Solutions		
	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Triceps Skinfold	.94	.94	.93	.92	.92	.91
Abdominal Skinfold	.92	.93	.91	.92	.93	.91
Subscapular Skinfold	.88	.87	.90	.89	.88	.90
Mat Creep	-.54	-.52	-.54	-.59	-.57	-.58
Shuttle Run	-.40	-	-.44	-.49	-.48	-.52
Factor 2						
Long Distance Run (Yards per Minute)	.72	.74	.76	.73	.77	.76
50-Yard Dash	.68	.64	.70	.68	.62	.70
Shuttle Run	.63	.56	.63	.68	.60	.69
Sit-Ups	.56	.61	.53	.57	.63	.55
Factor 3						
Right Grip	.82	.78	.93	.84	.79	.95
Left Grip	.74	.77	.66	.72	.79	.67
Factor 4						
Pull-Ups	.75	.61	.77	.74	.61	.76
Softball Distance	.69	.80	.66	.73	.84	.70
Arm Hang	.49	-	.51	.55	.47	.57

The residual intercorrelation matrix yielded three comparable common factors and one comparable specific factor for the cerebral palsied girls. Factor 1 is comprised of the three skinfold measures, mat creep, and shuttle run test items. Factor 1 might be considered to be a body composition factor which has a negative effect on certain speed items of cerebral palsied girls. Factor 2 is comprised of items which were labeled as power-endurance factors in the raw score matrix. It is possible that these test items are combined because the scores of cerebral palsied girls are lower in dash and shuttle run test items which move performance toward a power-endurance factor. Factor 2, thus, may be labeled a power-endurance factor. Factor 3 is a comparable specific factor comprised of the two grip strength measures. It might tentatively be labeled a strength factor. Factor 4 contains three variables which all involve the musculature of the arms and shoulders. Factor 4 appears to be an arm/shoulder power-strength factor. The factors extracted from the residual intercorrelation matrix of the cerebral palsied girls accounted for 70.6 percent of the total variance of the 14 test items.

The factor structure derived from the residual intercorrelation matrix for the cerebral palsied girls did not necessarily yield a more resolute factor structure than that derived from the raw score intercorrelation matrix. Each solution yielded three comparable common factors. The existence of Factor 1 (body composition), Factor 2 (power-endurance), and Factor 4 (arm/shoulder power-strength) would seem to be supported for the cerebral palsied girls. The power-speed factor, which is characteristic of preceeding groups, appears to be replaced by a power-endurance factor in the cerebral palsied girls groups because of the lower performance scores obtained by cerebral palsied girls on the dash and shuttle run. Furthermore, a comparable specific factor, defined by the grip strengths and labeled as a strength factor, would also seem to be confirmed.

Factor Structure for the Cerebral Palsied Boys

The results of the factor analyses obtained from the raw score matrix for cerebral palsied boys is presented in Table 4.17.

Three comparable common and one comparable specific factor emerged from the raw score intercorrelation matrix of the cerebral palsied boys. Factor 1 consists of the three skinfold measures and is clearly a body composition factor. Factor 2 is comprised of variables which place a premium on a force/time/coordination dimension. Since average performance on the dash and shuttle approaches or exceeds 30 seconds, Factor 2 might be termed a power-endurance factor. Factor 3 is defined by variables which involve force and power. Factor 3 appears to be an upper limb power-strength factor. Factor 4 is a comparable specific factor which consists solely of the leg raise item. No attempt will be made to attach a label to Factor 4. The three comparable common factors and one comparable specific factor extracted from the raw score intercorrelation matrix of the cerebral palsied boys accounted for 72.6 percent of the total variance of the 14 test items.

The results of the factor analyses performed on the residual intercorrelation matrix of the cerebral palsied boys is presented in Table 4.18.

The factor structure obtained from the residual intercorrelation matrix for the cerebral palsied boys consists of three comparable common factors and

TABLE 4.17. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR CEREBRAL PALSIED BOYS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Triceps Skinfold	.90	.89	.85	.90	.89	.86
Abdominal Skinfold	.88	.89	.88	.89	.90	.89
Subscapular Skinfold	.83	.83	.84	.82	.83	.84
Factor 2						
50-Yard Dash	.89	.90	.90	.91	.91	.91
Shuttle Run	.84	.86	.84	.84	.85	.84
Long Distance Run (Yards per Minute)	.78	.75	.80	.78	.75	.81
Mat Creep	.60	.62	.58	.60	.62	.59
Softball Distance	.58	.60	.57	.59	.61	.58
Sit-Ups	.56	.55	.57	.56	.55	.56
Factor 3						
Pull-Ups	.90	.89	.81	.91	.90	.82
Arm Hang	.78	.86	.73	.79	.87	.74
Left Grip	.71	.54	.78	.71	.59	.78
Right Grip	.60	.43	.63	.60	.49	.62
Factor 4						
Leg Raise	.40	-	.74	.41	-	.76

TABLE 4.18. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR CEREBRAL PALSIED BOYS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Triceps Skinfold	.96	.94	.93	.96	.94	.94
Abdominal Skinfold	.87	.88	.86	.88	.90	.87
Subscapular Skinfold	.84	.84	.84	.84	.84	.83
Factor 2						
50-Yard Dash	.90	.90	.90	.91	.91	.90
Shuttle Run	.82	.84	.83	.83	.84	.83
Long Distance Run (Yards per Minute)	.79	.76	.83	.80	.77	.83
Softball Distance	.67	.68	.65	.67	.68	.65
Mat Creep	.58	.58	.58	.60	.60	.60
Sit-Ups	.57	.57	.56	.56	.56	.55
Factor 3						
Pull-Ups	.87	.85	.83	.88	.85	.84
Arm Hang	.77	.82	.69	.78	.83	.70
Left Grip	.49	.46	.58	.49	.46	.58
Factor 4						
Leg Raise	.73	.71	.76	.74	.72	.77

one comparable specific factor. The three skinfold measures comprise Factor 1. Factor 1 appears to be a body composition factor. Factor 2 is defined by variables which are dependent upon time and/or explosive coordinated movement for their successful completion. In view of raw scores, Factor 2 seems to be a power-endurance factor. Factor 3 consists of items which involve the musculature of the hands and arms. Consequently, an upper limb strength/power-strength label seems appropriate. Factor 4 is represented solely by the timed leg raise test item; no attempt will be made to name this factor. The three comparable common and one comparable specific factors that define the factor structure derived from the residual intercorrelation matrix for cerebral palsied boys accounted for 70.1 percent of the total variance of the 14 test items.

The factor structures obtained for the cerebral palsied boys appear to be very similar. The major difference between the factor structure derived from the raw score matrix, when compared to the structure derived from the residual matrix, is that the right hand grip strength measure failed to load on Factor 3 in the residual matrix factor structure. The existence of the three comparable common factors (body composition, power-endurance, and upper limb strength/power-strength) and one comparable specific factor would seem to be supported for cerebral palsied boys.

Factor Structure of the Paraplegic Wheelchair Spinal Neuromuscular Participants

Due to the relatively low number of paraplegic wheelchair participants tested for this study, males and females were combined for the factor analyses. The results of the factor analyses extracted from the raw score matrix for paraplegic wheelchair participants is presented in Table 4.19.

TABLE 4.19. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RAW SCORE MATRIX) FOR PARAPLEGIC WHEELCHAIR SPINAL NEUROMUSCULAR PARTICIPANTS.

Factors	Orthogonal Solutions PC	RAO	Alpha	Oblique Solutions PC	RAO	Alpha
Factor 1						
Subscapular Skinfold	.88	.87	.90	.88	.88	.90
Triceps Skinfold	.82	.86	.78	.81	.86	.77
Abdominal Skinfold	.77	.77	.77	.77	.77	.77
Factor 2						
Shuttle Run	.84	.87	.83	.87	.90	.86
50-Yard Dash	.82	.79	.82	.82	.80	.81
Long Distance Run (Yards per Minute)	.66	.66	.67	.72	.72	.72
Factor 3						
Left Grip	.80	.89	.70	.82	.92	.73
Right Grip	.79	.90	.69	.81	.92	.71
Softball Distance	.61	.54	.60	.66	.61	.65
Arm Hang	.58	.40	.66	.61	.45	.68
Pull-Ups	.52	-	.58	.52	-	.58

Three comparable common factors emerged from the raw score intercorrelation matrix of the paraplegic wheelchair participants. Factor 1 appears to be a body composition factor, as it is comprised by the three skinfold measures. Factor 2 consists of three variables which place an emphasis on a time/force dimension. Since wheelchair participants straddle 30 seconds in their performance on the dash and shuttle run, Factor 2 might be labeled a power-speed or power-endurance item. For consistency with other groups, this will be labeled as a power-speed factor. Factor 3 consists of variables which require strength. Factor 3 appears to be an upper limb strength factor. The three comparable common factors extracted from the raw score intercorrelation matrix for the paraplegic wheelchair participants accounted for 72.8 percent of the total variance of the 11 test items.

The results of the factor analyses obtained from the residual intercorrelation matrix of the paraplegic wheelchair participants is presented in Table 4.20.

TABLE 4.20. FACTOR STRUCTURE OF PHYSICAL FITNESS TEST ITEMS (RESIDUAL MATRIX) FOR PARAPLEGIC WHEELCHAIR SPINAL NEUROMUSCULAR PARTICIPANTS.

Factors	Orthogonal Solutions			Oblique Solutions		
	PC	RAO	Alpha	PC	RAO	Alpha
Factor 1						
Subscapular Skinfold	.89	.88	.90	.89	.88	.90
Triceps Skinfold	.80	.83	.79	.80	.83	.79
Abdominal Skinfold	.76	.75	.76	.75	.75	.75
Factor 2						
Shuttle Run	.83	.83	.84	.88	.88	.87
50-Yard Dash	.83	.82	.81	.82	.83	.80
Long Distance Run (Yards per Minute)	.65	.64	.67	.71	.70	.72
Factor 3						
Right Grip	.83	.90	.75	.87	.93	.81
Left Grip	.79	.88	.72	.84	.91	.78
Arm Hang	.65	.53	.71	.66	.55	.72
Softball Distance	.63	.61	.60	.68	.66	.66
Pull-Ups	.53	.43	.57	.53	.43	.57

Three comparable common factors emerged from the residual intercorrelation matrix for the paraplegic wheelchair participants. Factor 1 is defined by the three skinfold measures and appears to be a body composition factor. Factor 2 consists of variables which are dependent upon time and wheelchair propulsion. Factor 2 appears to be a power-speed factor. Factor 3 is comprised of variables which predominantly involve the musculature of the upper limbs. Factor 3 might be labeled an upper limb strength factor. The three comparable common factors extracted from the residual intercorrelation matrix of the paraplegic wheelchair participants accounted for 73.7 percent of the total variance of the 11 test items.

The factor structures obtained from the raw score intercorrelation matrix and the residual intercorrelation matrix were very similar. Age did not appear to have a generalizing effect upon this group of subjects. The existence of the three factors which emerged on each solution would seem to be supported. In the case of wheelchair participants, three, rather than four, factors emerged. This was due to the combining of power-strength items such as the arm hang and pull-up merging with grip strength items. Since the grip items were more predominant, the factor was identified as a strength factor.

The factors of body composition and power-endurance, although perhaps less resolute, were both extracted for cerebral palsied subjects. The power-speed factor, which was characteristic of the normal, auditory, and visual groups, appeared as a power-endurance factor since the scores of cerebral palsied subjects were relatively larger on dash and shuttle run items. Cerebral palsied boys exhibited a strength/power-strength factor, whereas cerebral palsied girls exhibited separate factors for strength and power-strength.

Body composition, power-endurance, and strength/power-strength emerged as factors for paraplegic wheelchair participants. This corresponded to the factor structure exhibited by cerebral palsied boys.

Summary

Although not tested statistically for similarities, it can be reported, with some degree of confidence, that the factor structures of the subject groups exhibited similar (but certainly not identical) patterns. Some differences between factor structures derived from the raw score and residual intercorrelation matrices were observed. The extent of these differences varied from group to group.

The most robust factors extracted were those labeled body composition. Regardless of the subject group or intercorrelation matrix analyzed, the body composition factor emerged.

For the normal, auditory impaired, and visually impaired groups, support was also found for factors of strength, power-speed, and power-strength. Normal and visually impaired girls exhibited five extracted factors while the boys from these groups had only four. This was apparently due to partitioning power-strength into a factor containing power-strength (flexed arm hang and pull-ups), and another consisting primarily of trunk/hip flexibility power-endurance (sit and reach, trunk raise, and leg raise). The partitioning may have been due, in part, to the supposition that flexibility (as measured by the sit and reach) was related to the power-endurance measures (especially trunk raise) in that it provided the flexible performer a mechanical advantage on the endurance task which was unavailable to those less flexible.

In summary, factors of body composition, strength, power-strength, power-speed, and power-endurance appear to best reflect the factor structure of the groups and test items considered. In the case of cerebral palsied boys and wheelchair spinal neuromuscular participants, the strength and power-strength factors were combined to form a combined factor. The power-speed factor emerging for normal, auditory impaired, and visually impaired groups emerged

for the cerebral palsied and wheelchair spinal neuromuscular groups. However, the factor was identified as power-endurance in the latter groups because mean performance straddled or exceeded 30 seconds. The only other power-endurance factor which emerged without flexibility as an influence was found for the sample of auditory impaired boys. A hip/trunk flexibility/power-endurance emerged in either the raw score or residual matrices for normal girls, auditory impaired girls, and visually impaired girls. Finally, the leg raise appeared as a specific factor for cerebral palsied boys. No attempt was made to label this factor.

The hypothesized factor structure, as reported in Chapter 1, was amended on the basis of the factor analysis. The body composition factor was the only factor maintained as an intact factor. The items which comprised the hypothesized muscular strength/endurance factor were partitioned into factors of strength, power-speed, power-strength, or power-endurance in the factor analysis. The hypothesized speed and agility factors were merged to define a power-speed or power-endurance factor.

Separate factors of flexibility and cardiorespiratory endurance did not clearly emerge from the factor analysis. This could be due to the fact that only one test item was used to define each of these factors. With no other items hypothetically related to these constructs, it became especially difficult to extract these factors from the data. The fact that flexibility and cardio-respiratory endurance did not clearly emerge, therefore, was due, to a large extent, to the absence of other items which may have helped to better define these constructs. The items which comprised the flexibility (sit and reach) and cardiorespiratory (long distance run) hypothesized factors loaded on other factors. The sit and reach test emerged for normal, auditory, and visually impaired girls on a factor which included the trunk raise and leg raise. It was suggested, however, that the emergence of this factor was due to the flexibility component.

The long distance run item loaded either on the power-speed or power-strength factors. In addition to the cardiorespiratory demands of the task, the long distance run makes demands on the muscular system as well. This is apparently a reason why the long distance run loaded on power-related factors, particularly in the absence of other cardiorespiratory items in the design.

In view of test item selection, the flexibility and cardiorespiratory components were not supported or unsupported by the physical fitness factor analysis conducted in this study. Thus, they can be maintained and justified on the basis of past research and logic.

CHAPTER V

SYNTHESIS, SUMMARY, AND IMPLICATIONS

Introduction

This chapter primarily presents a synthesis and summary of the results of the study and applies the results of the study to the development of a valid and reliable test of physical fitness and to an identification of other curricular implications pertaining to the physical fitness abilities of orthopedically and sensory impaired children and youth. In originally designing the study, seven objectives were delineated. These seven objectives appear in Chapter I and serve as the basic underlying structure for the material presented in this chapter. Essentially, the chapter begins with an analysis of physical fitness performance as a function of group/condition. From this beginning, age trends pertaining to the physical fitness development of normal, orthopedically, and sensory impaired boys and girls are analyzed, identified, and compared. The third part of the chapter summarizes and presents an analysis of sex influences on the physical fitness of normal, orthopedically impaired, and sensory impaired boys and girls. The next section summarizes an analysis of physical fitness in terms of associated factors including physical education experiences, geographical location, community size, and educational environment. The fifth part of the chapter identifies and compares the factor structure of physical fitness abilities of normal, orthopedically impaired, and sensory impaired boys and girls. The results of factor analysis leads to the next section of the chapter in which a physical fitness test based on the factor structure is proposed for normal, sensory impaired, and orthopedically impaired children and youth. The last part of the chapter identifies additional curricular implications pertaining to physical fitness on the basis of the results of this study.

A Comparison of the Physical Fitness of Normal, Orthopedically, and Sensory Impaired Boys and Girls

Physical Fitness Performance and Handicapping Condition

In comparing the performance of normal subjects with auditory impaired subjects, it was found that the performance of normal subjects was never exceeded significantly by the performance of the auditory impaired group (skinfolds excluded). It was also found that for a number of test items, no significant differences were found between normal and auditory impaired subjects. These items included the standing broad jump, the 50-yard dash, mat creep, right and left grip strength, long distance run, pull-ups, triceps skinfold (boys), sit and reach (boys), and softball throw (girls). Significant differences were found at one age or more for abdominal skinfold, subscapular skinfold, sit-ups, leg raise, trunk raise, shuttle run, arm hang, triceps skinfold (girls), sit and reach (girls), and softball throw for distance (boys). While significant differences between normal and auditory impaired subjects were found, the magnitude of difference between normal and auditory impaired subjects, in no test item, exceeded one standard deviation. In fact, most standard deviation scale units between these groups did not exceed 0.25. Individuals with auditory impairments were found to exceed the median performance of normal subjects to a

relatively (compared to other groups) great extent. Thus, the performance standards attained by normal subjects are well within the reach of subjects with auditory impairments.

In comparing the performance of normal subjects and subjects with visual impairments, it was also found that the performance of normal subjects was never exceeded by the performance of the visually impaired group (skinfolds excluded). The number of test items on which significant differences were found between normal and visually impaired subjects was greater than that found between normal and auditory impaired subjects. Specifically, no significant differences were found between normal and visually impaired subjects on pull-ups, triceps skinfold (boys), and sit and reach (boys). Significant differences between normal and visually impaired subjects were found at one age or more for abdominal skinfold and subscapular skinfold (visually impaired had larger skinfolds), sit-ups, leg raise, trunk raise, mat creep, shuttle run, right and left grip strength, flexed arm hang, 50-yard dash, softball throw for distance, standing broad jump, long distance run, triceps skinfold (girls), and sit and reach (girls).

The largest differences between normal and visually impaired subjects tended to occur in softball distance and those items involving moving to a visual target in the fastest possible time. Although individuals with visual impairments were at an obvious disadvantage in running with a partner or guide wire, analysis of data indicated that below normal performance could not be attributed solely to differences in ambulation, i.e., there appear to be real differences in physical fitness. The magnitude of differences between normal boys and those with visual impairments is least in items pertaining to flexibility, certain items involving muscular strength/endurance, and skinfold measurements. In regard to girls, the magnitude of differences between normal girls and visually impaired girls is smallest in pull-ups. This could be attributed to the fact that neither group performed well on this test item. Results pertaining to coefficient of variation indicate that individuals with visual impairments appear to be more variable in their performance than normal subjects. Although many individuals with visual impairments exceed median performance values of normal subjects, individuals with visual impairments, as a group, do not exceed the median performance values of normal subjects to as great an extent as do individuals with auditory impairments. Skinfold measurements, grip strength, and sit and reach are the areas in which male individuals with visual impairments compare most favorably with normal boys. Females with visual impairments compare most favorably with normal girls on skinfold, leg raise, arm hang, sit and reach, and the long distance run. The poorest performances of males with visual impairments in comparison with normal males in terms of percent of subjects above the median occurred in softball throw for distance, long distance run, sit-ups, mat creep, and shuttle run. The poorest performances of females relative to percent of individuals above the median occurred in shuttle run, mat creep, 50-yard dash, softball distance, broad jump, right grip strength, and sit-ups.

In regard to comparisons between auditory and visually impaired subjects, no significant differences were found on triceps skinfold, abdominal skinfold, subscapular skinfold, sit-ups, leg raise, sit and reach, and pull-ups (girls). Significant differences between the auditory impaired and visually impaired subjects were found at one age or more on the following items: trunk raise,

mat creep, shuttle run, right grip, left grip, flexed arm hang, 50-yard dash, standing broad jump, softball distance, long distance run, and pull-ups (boys). The performance of auditory impaired subjects generally exceeded that of children and youth with visual impairments.

In comparing the performance of normal subjects with cerebral palsied subjects, it was found that, with the exception of the skinfold measures, the performance of girls on the pull-up test, and the performance of 17-year old girls on left grip, significant differences favoring normal subjects were found on all test items in which comparisons were made. The cerebral palsy group was the only major group which generally did not differ significantly from normal subjects on skinfold measures.

Relative to test items measuring muscular strength/endurance, individuals with cerebral palsy are generally between one and two standard deviations below the performance of normal subjects. In "running" test items, they are far below performance of normal subjects. Although differences in "running" test items may be attributed, in part, to differences in methods of ambulation, they also appear to be attributable, to some extent, to real differences in physical fitness. Except in skinfold measurements, subjects with cerebral palsy are more variable in their performance than normal subjects. Unfortunately, few individuals with cerebral palsy were found to exceed median performance levels of normal individuals in Project UNIQUE test items. Most favorable comparisons with normal youngsters were in skinfold measurements.

Spinal neuromuscular and normal subjects were compared on seven Project UNIQUE test items to determine whether significant differences existed between the two groups. Except for skinfolds, the scores of the normal subjects were generally significantly superior to those of the spinal neuromuscular subjects on grip strength, arm hang, and pull-ups. No significant differences, however, were found between younger (10-13) normal and spinal neuromuscular boys on the grip strength measures. In addition, no significant differences were found between older (14-17) normal and spinal neuromuscular girls on left hand grip strength, or between normal and spinal neuromuscular girls (both age groups) on pull-ups. Although not all comparisons were significant, there was a trend for spinal neuromuscular subjects to have a larger skinfold than normal subjects.

In terms of variability of performance, as determined by coefficients of variation, individuals with spinal neuromuscular conditions are more variable than normal subjects, but somewhat less variable in their scores than individuals with cerebral palsy. Most youngsters labeled as spinal neuromuscular who exceeded median level points of normal subjects did so in the area of skinfold measurements.

In regard to individuals with congenital anomalies or amputations, comparisons with normal subjects were limited in this study. Test results were not tested for significant differences. Descriptive results are similar to those found in the other two groups included in the orthopedic category in regard to magnitude of differences in performance or percent of subjects scoring above median points for normal subjects. Individuals with congenital anomalies/amputations appeared to be more variable in their performance than normal subjects.

Physical Fitness Test Performance as a Function of Severity of Handicapping Condition

One of the factors that has been believed and found to affect physical fitness has been the severity of handicapping condition. Information pertaining to severity of handicapping condition was pursued as a part of Project UNIQUE relative to the auditory impaired sample, the visually impaired sample, cerebral palsied subjects, and spinal neuromuscular subjects for whom site of spinal cord lesion was reported.

Auditory impaired subjects were subclassified as either hard of hearing or deaf, and comparisons in performance were made based on these subclassifications. Results from Project UNIQUE data indicated that, with two exceptions, no significant differences were found between hard of hearing and deaf participants on 17 Project UNIQUE test items. In one exception, 13-year old deaf students had significantly higher left hand grip strength scores than 13-year old hard of hearing students. In the second exception, 16-year old deaf students performed significantly more sit-ups than 16-year old hard of hearing students. These results are based on analyzing data on 157 hard of hearing boys, 666 deaf boys, 108 hard of hearing girls, and 537 deaf girls.

In relationship to the visually impaired sample, the analysis which was conducted investigated performance between partially sighted and blind subjects. Subjects for the study included 185 partially sighted girls, 304 partially sighted boys, 77 blind girls, and 83 blind boys. The results of the study indicated that degree of visual impairment was found to be a significant factor on six of the Project UNIQUE test items. On each of these items, the difference between the means favored the partially sighted subjects. Five of these items were characterized by some form of movement through space (jumping) or moving through space toward a target (running, creeping). The sixth item involved throwing. Activities which require movement through space (particularly running to visual cues) and throwing have been previously identified as tasks in which blind individuals score low because of their sight disadvantages (Winnick, 1979).

In analyzing the effects of severity of condition on performance in the cerebral palsy group, comparisons were made between subjects in Classes III through VII in terms of the 1979 NASCP Classification System. The numbers of subjects in each of the classes were as followed: Class III, N=62; Class IV, N=37; Class VA, N=25; Class VB, N=64; Class VI, N=43; and Class VII, N=90. The results of the analysis indicated that the severity of the condition as defined by the NASCP system was a significant factor on approximately one-half of the test battery administered to cerebral palsied subjects. Significant F ratios were recorded for sit-ups, mat creep, shuttle run, the two grip strength measures, 50-yard dash, standing broad jump, softball throw, and long distance run. In general, the higher classes (less severely involved) achieved superior scores when compared to the lower classes on these items. The most notable exception appeared to be the performance of Class IV participants on the grip strength measures. Class membership was not a significant factor relative to skinfold measures, leg raise, trunk raise, sit and reach, arm hang, or pull-ups.

In regard to individuals with spinal neuromuscular conditions, severity of condition was defined by the site of spinal cord lesion and was similar to the classification system utilized by the National Wheelchair Athletic Association. The site of spinal cord lesion was operationally defined by the following categories: cervical region (N=7), lesions between T1 and T5 inclusive (N=5), lesions between T6 and T10 inclusive (N=36), lesions between T11 and L2 inclusive (N=39), and lesions at L3 or below (N=33). Because of the low number of subjects in the first two categories, they were eliminated from the analysis. Of the 11 Project UNIQUE test items which were appropriately administered to these individuals, a multivariate ANOVA indicated that site of lesion was not a significant factor on Project UNIQUE test items. Thus, the project UNIQUE battery did not discriminate between performances of spinal cord injured participants with lesions occurring at T6 or below.

Physical Fitness Test Performance as a Function of Onset of Handicapping Condition

In view of the contention that physical fitness scores of visually impaired individuals are affected by age of onset of handicapping condition, data were analyzed in terms of the variable of onset of handicapping condition in the case of visually impaired subjects. Age of onset categories and numbers of subjects included: congenital, N=476; occurring between birth and age six, N=125; and occurring after age six, N=48. Each of these categories was also grouped with condition (partially sighted or blind). Results of the study indicated nonsignificant differences for age of onset and the interaction between the age of onset and condition. Because of this finding, it was concluded that age of onset was not a significant variable in the performance of Project UNIQUE physical fitness measures.

Performance of Run Items as a Function of Method of Ambulation

In this study, test items involving running were modified in terms of the abilities of participants. These modifications resulted in different methods of ambulation which needed to be considered as procedural modifications and in data analysis for visually impaired subjects and for the orthopedically impaired subgroups. Since these were major modifications, it was necessary to code method of ambulation and to analyze data in terms of these methodological differences. In their performance, visually impaired participants employed one of three running methods when performing the dash, the shuttle run, and the long distance run. Depending on the visual condition, subjects could run with a partner, with the aid of a rope or guide wire, or unassisted. A one-way univariate ANOVA procedure found that subjects who performed the running events unassisted obtained superior scores to subjects who ran with the use of a guide wire. Unassisted subjects also significantly exceeded the performance of partner-assisted subjects on the 50-yard dash; however, no statistical difference was found between unassisted subjects and partner-assisted subjects on either the shuttle run or the long distance run. The performance of partner-assisted and guide wire-assisted subjects differed significantly only on the shuttle run where verbal and/or tactual cues provided by the partner may have been helpful in improving performance. While some subjects were classified as blind and did run unassisted, the majority of blind subjects ran with assistance and the majority of the partially sighted subjects ran unassisted.

Since running method was found to be a significant factor on performance, an additional analysis was performed to compare visually impaired subjects who ran unassisted with normal subjects on the three running items. This analysis was performed to determine if differences observed between normal and visually impaired subjects on running items discussed earlier were due solely to differences in procedures (running methods). This analysis found that the differences between visually impaired and normal subjects was significant on all three running items and confirmed that this difference was not due solely to variations in running method.

The relationship of running method and performance by cerebral palsied subjects was also analyzed for the 50-yard dash, the shuttle run, and the long distance run. The running methods consisted of wheelchair participation, the use of an assistive device (cane, crutches, or walker), and unassisted. (The number of subjects per running method for each event is provided in Table 3.19.) Significant differences were found among running methods on all three running items. Subjects who ran without assistance made superior scores to subjects who performed in wheelchairs on each running item. Unassisted runners also significantly surpassed the performance of runners who used assistive devices on the shuttle run and long distance run. Despite a 20-second mean difference in performance, the means of the unassisted and the assistive device groups did not differ significantly on the 50-yard dash. Participants using assistive devices significantly exceeded the performance of wheelchair participants on the 50-yard dash and shuttle run, but no significant difference was found between these groups on the long distance run. It was considered particularly interesting that subjects who used assistive devices were significantly faster than wheelchair counterparts over a shorter distance (shuttle run or dash) but not over longer distances (long distance run).

Since running method or method of ambulation was found to be a significant factor within the cerebral palsy group, an additional analysis was performed to determine whether running performance between normal and cerebral palsied subjects could be attributable solely to differences in procedures. In this analysis, unassisted cerebral palsied youngsters were contrasted with normal runners. As expected, the result of this analysis indicated that differences in running items were not due solely to differences in methods of ambulation.

Based on the analysis of performance as a function of method of ambulation, it is clear that scores are affected by method of ambulation. However, differences in the methods of ambulation employed in this study did not account solely for the differences in scores between normal youngsters and youngsters with handicapping conditions. Based on the results of this study, it is necessary to take into account methods of ambulation when administering appropriate test items to determine youngsters level of functioning and in planning activities for them.

Age Trends and Physical Fitness Performance

The influence of age on skinfold measures and performance on physical fitness items was studied for the five major groups in this study: normal, auditory impaired, visually impaired, cerebral palsy, and spinal neuromuscular. In analyzing the influence of age, each specific age from 10 to 17 was independently considered for the normal, auditory impaired, visually impaired,

and cerebral palsy groups. In the case of the spinal neuromuscular group, ages were combined to form two groups: a 10 to 13 year age group and a 14 to 17 year age group. Ages in the spinal neuromuscular group were combined because of the lack of adequate subject numbers at each specific age from 10 to 17.

Generally speaking, age was found to be a significant factor on skinfold measurements. The results of the study generally indicated that as age increases, skinfold measurement increases. Girls in each of the five major groups of the study had increased triceps skinfold with age. The only exception to this pattern was in the case of triceps skinfold for normal boys, boys with auditory impairments, boys with visual impairments, and boys classified as cerebral palsied. In each of these groups, older boys had smaller triceps skinfolds than younger boys. Age was not a significant factor for spinal neuromuscular boys. In regard to abdominal skinfold, skinfolds increased with age in the case of both boys and girls in each of the five major groups of the study. In the case of subscapular skinfold, the skinfold was greater with age for both boys and girls in the case of normal subjects, visually impaired subjects, auditory impaired subjects, and the cerebral palsied subjects. Age was not a significant factor relative to the abdominal skinfolds of spinal neuromuscular subjects.

In analyzing the performance of normal subjects, auditory impaired subjects, and visually impaired subjects on other (non-skinfold) test items, it was found that performance tended to improve with age. Significant improvement was found for both boys and girls on the leg raise, standing broad jump, 50-yard dash, mat creep, sit and reach, right grip strength, left grip strength, and softball throw for distance. Significant differences for boys, but not girls, were found on sit-ups, pull-ups, the long distance run, and the flexed arm hang. Age was not a significant factor for girls on the long distance run, pull-ups, flexed arm hang (ages 11-13), and the shuttle run. Interestingly, in the shuttle run, age was a significant factor for normal and auditory impaired boys (older subjects attained higher scores), but was not significant for normal girls, auditory impaired girls, visually impaired boys, and visually impaired girls. Where improvements were made with increasing age in the case of boys, improvements were noted throughout the 10-17 age range. On the other hand, girls showed a leveling off at age 12 in the broad jump and the 50-yard dash. The rate of improvement was greater for boys than girls at age 14 in the right grip strength measure and at age 13 in the left grip strength measure. On the flexed arm hang, age was not significant for girls between the ages of 11 and 13, but was significant between 13 and 16 years of age (performance increased). In the softball throw for distance, age was a significant factor for both boys and girls for normal, auditory impaired, and visually impaired subjects, but the rate of improvement was greater for boys than girls (especially for normal boys and auditory impaired boys). Overall, when considering the normal, auditory impaired, and visually impaired samples, performance tended to improve with age with some leveling off on certain items for girls between ages 12 and 14. Also, the rate of improvement was found to be greater for boys than for girls at later age levels on certain test items.

In relationship to subjects with orthopedic impairments, age was found to be a significant factor for cerebral palsied subjects in only three non-skinfold test items. These items included right grip strength and left grip

strength for both boys and girls, and pull-ups for boys. In each of these cases, performance improved with age.

In regard to subjects with spinal neuromuscular conditions, age was significant for these subjects on right grip (older subjects had higher grip strength), for spinal neuromuscular girls on left hand grip strength (older subjects with higher scores), and for spinal neuromuscular boys on pull-ups (older boys with higher scores). Thus, in relationship to the spinal neuromuscular group and the cerebral palsied group, age was a factor for right grip, left grip, and pull-ups. In regard to grip strength, performance improved with age. In regard to pull-ups, boys improved with age and girls did not change significantly.

On the basis of the results of this study, it is clear that age must be considered as a factor in physical fitness test results in the case of normal subjects, auditory impaired subjects, and visually impaired subjects. In the case of subjects with orthopedic impairments, age did not play as great a role on physical fitness test items (skinfolds excluded). In the case of skinfold measurements, age should be considered for subjects with orthopedic impairments as well. Finally, where age was a factor, performance scores generally improved with age. Exceptions were noted in certain cases in which girls tended to level off. Also, in certain instances, the rate of improvement for boys tended to be greater than for girls.

Sex Trends and Physical Fitness

Sex was found to be a significant factor on most test items for most subject groups. When normal, auditory impaired, and visually impaired subjects were analyzed, sex was found to have a similar effect on the performance of each group. Generally speaking, girls were found to have significantly larger skinfolds than boys and higher sit and reach scores than boys. With the exception of the trunk raise where no sex difference was found, boys exceeded the performance of girls on all other test items. There were three exceptions to this pattern. The difference between normal boys and girls on the triceps skinfold was not found to be significant, and no statistically significant differences were found between visually impaired boys and girls on either shuttle run or sit and reach.

Fewer significant sex differences existed for subjects with cerebral palsy or spinal neuromuscular conditions. For cerebral palsied subjects, girls were found to have larger triceps and abdominal skinfolds than boys. Cerebral palsied boys surpassed the performance of cerebral palsied girls on leg raise, arm hang, 50-yard dash, standing broad jump, and softball throw. No differences were found between cerebral palsied boys and girls on subscapular skinfold, sit-ups, trunk raise, mat creep, shuttle run, sit and reach, grip strength, pull-ups, or long distance run. For spinal neuromuscular subjects, sex was found to be a significant factor on only one test item. Boys with spinal neuromuscular conditions threw the softball farther than girls with spinal neuromuscular conditions. No differences were found between spinal neuromuscular boys and girls on the remaining test items (skinfold, grip strength, arm hang, pull-ups, 50-yard dash, and long distance run).

Physical Fitness Performance as a Function of Community Size, Geographical Location, Educational Environment, and Physical Fitness Experiences

One of the objectives of the project was to study the physical fitness performance of subjects included in the study as a function of associated factors influencing performance. For the purposes of this study, the associated factors include community size, geographical location, educational environment, and physical education experiences. In studying these factors, not all major subgroups of the subject population were considered for each factor. In the case of community size, only the normal population was considered. The analysis of educational environment was limited to groups with handicapping conditions since institutionalization and residence are not applicable to the normal population. An analysis of physical education experiences and geographical regions as factors influencing physical performance pertain to all major subject groups.

Community Size

In analyzing data of normal subjects as a function of community size, it was necessary to define community size. Community size was conceptualized as either urban (population of 200,000 or greater), suburban (population equal to or greater than 10,000 but less than 200,000), and rural (population less than 10,000). Of the 681 girls involved in the normal sample, 180 were educated in an urban community, 319 in a suburban community, and 182 in a rural community. Of the 511 boys involved in the normal sample, 92 were determined to be educated in an urban community, 304 in a suburban community, and 115 in a rural community. The results of the analysis indicated that community size was a significant main effect in the absence of significant interaction (community size x sex) for three items: leg raise, trunk raise, and standing broad jump. Suburban subjects were found to have significantly higher scores than either urban or rural subjects on the leg raise. On the timed trunk raise, suburban subjects were found to be superior to urban subjects. Urban subjects exceeded the performance of suburban and rural subjects on the standing broad jump.

Significant community size by sex interaction emerged on eight additional test items: triceps skinfold, abdominal skinfold, subscapular skinfold, sit-ups, mat creep, right grip strength, left grip strength, and flexed arm hang. For boys, significant differences were found on sit-ups, mat creep, and flexed arm hang only. In the sit-up, suburban boys significantly exceeded the performance of urban and rural boys. In the mat creep, suburban boys significantly exceeded the performance of urban boys; however, rural boys did not differ significantly from either group. In the flexed arm hang, rural boys had significantly higher flexed arm hang times than either suburban or urban boys. Although these results are interesting, no definitive pattern of differences was apparent relative to boys.

A somewhat greater number of differences existed for girls than boys. For girls, significant differences were found in triceps and abdominal skinfolds (urban girls had significantly larger skinfolds than either suburban or rural girls), subscapular skinfold (urban girls were found to have significantly larger skinfolds than rural girls and rural girls were found to have significantly larger skinfolds than suburban girls), mat creep (suburban and rural girls

recorded significantly faster mat creep times than urban girls), and right and left grip strength (rural girls had significantly higher grip strength scores than urban girls; suburban girls did not differ significantly from either group). Thus, there appeared to be a tendency for the test item performance (skinfolds excluded) of urban girls to be inferior to that of suburban and rural girls, and for girls in urban settings to possess larger skinfolds than girls in the other community settings. An exception to this was the standing broad jump test in which girls in urban settings exceeded the performance of those in suburban and rural settings.

The results pertaining to the relationship of community size and physical fitness performance should be considered exploratory at this point. In view of the lack of a definite pattern emerging in relationship to this question, no implications will be or are recommended.

Geographical Location

Another relatively minor objective of Project UNIQUE was to study the physical fitness of subjects as a function of geographical location, i.e., as a function of northeast, southeast, central, northwest, or southwest areas of the United States. Unfortunately, there was a wide disparity in the number of subjects tested in each of these areas. The actual number of subjects and percent total by each region was: northeast, N=1,450, 37.1%; southeast, N=614, 15.7%; central, N=1,196, 30.5%; northwest, N=149, 3.8%; southwest, N=505, 12.9%. An analysis of subjects tested by geographical areas indicated that a disproportionate number of subjects were tested within regions, and insufficient numbers of subjects were tested in the northwest and southwest regions. For example, in the northwest region, only four boys and three girls with orthopedic impairments were tested. In view of the disparity of subjects tested within regions, the lack of subject numbers in certain subgroups, the fact that his was a very minor part of the study (for which the study was not primarily designed), and because of perceived limited implications, the influence of geographic loaction on performance was not pursued.

Educational Environment

For this study, educational environment was essentially defined in terms of school placement and residence. Impaired subjects were classified as either institutionalized residents, institutionalized nonresidents, or non-institutionalized. Subjects were considered to be institutionalized if all students attending the subject's school were deemed handicapped, i.e., a segregated setting. Thus, an institution was considered either a public or private segregated school. If normal subjects attended the same school as a handicapped individual, the school and, of course, the subject were considered non-institutionalized. This was true even if a subject was educated in a self-contained special class within the school. Subjects residing at an institution were identified as institutionalized resident. On the other hand, individuals who attended institutions which were segregated but who did not reside at the institution were identified as institutionalized nonresidents.

The number of auditory impaired subjects according to educational environment was as follows: girls - 365 institutionalized resident, 197 institutionalized nonresident, and 83 non-institutionalized; boys - 480 institutionalized

resident, 227 institutionalized nonresident, and 116 non-institutionalized. In regard to the auditory impaired sample, educational setting was found to be a significant factor on 15 of the 17 Project UNIQUE test items. Eleven of the test items yielded significant main effect F values for educational setting in the absence of significant interaction. On four items, a significant educational setting by sex interaction emerged. Although the superiority of groups and subgroups varies from item to item, there was a trend for the performance of non-institutionalized subjects to be generally inferior to the performance of institutionalized subjects. This conception of trend is based on the fact that of 12 of 13 performance items (skinfolds excluded), the performance of the non-institutionalized group was surpassed by the performance of at least one of the institutionalized groups. In addition, on the triceps skinfold, the institutionalized resident group had significantly larger skinfolds than institutionalized nonresidents, and institutionalized residents had significantly larger abdominal skinfolds than institutionalized nonresidents and non-institutionalized subjects at the .05 level (this was the only instance in which a significant F value favored the non-institutionalized subgroup). It appears that, in general, auditory impaired subjects who were "institutionalized" were more successful in physical fitness test items than those who were "non-institutionalized."

In analyzing the performance of visually impaired subjects as a function of educational settings, the following sample sizes were involved: girls - 146 institutionalized resident subjects, 40 institutionalized nonresident subjects, and 76 non-institutionalized subjects; boys - 242 institutionalized resident subjects, 47 institutionalized nonresident subjects, and 98 non-institutionalized subjects. The results of the data analysis indicated that educational setting was found to be a significant factor on nine of the 17 Project UNIQUE physical fitness items which were analyzed. Of the nine items, three were skinfold items. Of the remaining six items, the non-institutionalized group was found to be inferior to at least one of the institutionalized groups in every case. Relative to the skinfold measures, the non-institutionalized group was found to have significantly lower skinfolds than the institutionalized subjects. Although educational setting was not significant on as many variables as was true for auditory impaired subjects, the results pertaining to the visually impaired subjects were similar in that subjects from institutionalized settings were superior to the non-institutionalized group in each case where significance occurred (skinfolds not included).

In regard to the cerebral palsied subjects, the following numbers and categories existed: girls - 21 institutionalized nonresidents, 38 institutionalized residents, 119 non-institutionalized; boys - 25 institutionalized nonresidents, 46 institutionalized resident, and 147 non-institutionalized. In the case of the cerebral palsy group, the main effect of educational setting was significant on only three items: mat creep, shuttle run, and right hand grip strength. On the mat creep and shuttle run, non-institutionalized subjects made significantly faster times than institutionalized nonresidents. Institutionalized residents had significantly higher scores than institutionalized nonresidents on the right hand grip strength (.05 level). These results support the contention that educational setting is not generally a significant factor for cerebral palsied subjects.

For the analysis pertaining to individuals with spinal neuromuscular conditions, the number and classification of subjects included: girls - eight institutionalized nonresident, 18 institutionalized resident, and 47

non-institutionalized; boys - 10 institutionalized nonresidents, 16 institutionalized residents, and 48 non-institutionalized. Multivariate ANOVA results indicated that neither the interaction of educational setting and sex nor the main effect of educational setting was significant. Thus, it may be concluded that educational setting was not a significant factor relative to the physical fitness performance of subjects with spinal neuromuscular conditions.

On the basis of the analysis that was conducted relative to educational environment, it becomes clear that educational environment was not a factor in the orthopedic subgroups. On the other hand, educational environment appeared to be related to physical fitness performance in groups identified as sensory impaired. Where significance was found in regard to the sensory impaired groups, it was generally in favor of the institutionalized subjects. More test items were significantly affected for auditory impaired subjects than for visually impaired subjects. The data eminating from this analysis are not in agreement with the prevalent conception that the performance of individuals in non-institutional settings exceeds that of individuals in institutionalized settings.

Factor Structure of Physical Fitness

As a result of the activities involved in this study, a factor structure of physical fitness for the major groups of the study was developed and adopted. Although not tested statistically for similarities, it can be reported, with some degree of confidence, that the factor structures of the major subject groups exhibited similar but not identical patterns.

The most robust factors extracted from the data were those labeled body composition. Regardless of the subgroup or intercorrelation matrix analyzed, the body composition factor emerged. It was also evident that all groups exhibited common factors within the generic area labeled muscular strength/endurance. For the normal, auditory impaired, and visually impaired groups, support was found for factors of strength, power-speed, and power-strength. Normal and visually impaired girls exhibited five extracted factors, while the boys from these groups had only four. This was apparently due to partitioning power-strength into a factor containing power-strength (flexed arm hang and pull-ups) and another consisting primarily of trunk-hip flexibility power-endurance (sit and reach, trunk raise, and leg raise).

The procedures and test items selected in this study resulted in the identification of strength, power-speed, and power-strength factors for normal subjects, individuals with auditory impairments, and individuals with visual impairments. In the case of individuals with cerebral palsy, factors of power-strength, strength, and power-endurance were supported, to at least some extent, in the cases of both boys and girls. The power-speed factor was not exhibited in the cerebral palsy group because the 50-yard/meter dash, which was a reflection of power-speed in the normal, auditory, and visual groups, was designated as a power-endurance factor in the case of individuals with cerebral palsy. A strength and power-endurance factor was evidenced for paraplegic wheelchair spinal neuromuscular subjects. The fact that the power-endurance rather than a power-speed factor emerged was attributed to the need for individuals participating in wheelchairs to take more time in executing the 50-yard/meter dash. (In view of the lack of subject numbers, a factor

structure was not developed in connection with the congenital anomalies/amputees subject sample. Since individuals with these impairments are essentially able-bodied, except for involvement of one or more extremities, the factor structure presented in connection with the normal population was adopted for this group.)

The data eminating from this study did not identify a factor structure of physical fitness which included flexibility and cardiorespiratory endurance. This could be due to the fact that only one test item was used to define each of these factors. With no other items hypothetically related to these constructs, it became especially difficult to extract these factors from the data. These two components were essentially hypothesized in the original conceptualization and were not supported or unsupported by this study.

Thus, the hypothesized factor structure as reported in Chapter I was amended on the basis of the factor analysis. The body composition factor was maintained as an intact factor. The items which comprised the hypothesized muscular strength/endurance factor were partitioned into factors of strength, power-speed, power-strength, or power-endurance as a result of factor analyzing project data. The hypothesized speed and agility factors merged to define either the power-speed or power-endurance factor. As mentioned previously, flexibility and cardiorespiratory endurance, which were hypothesized originally, were not supported or unsupported by the data.

In view of the data that were collected and analyzed, previous research, and on the basis of logical considerations, it is believed that the factor structure of physical fitness of the groups involved in the present study includes body composition, muscular strength/endurance, flexibility, and cardiorespiratory endurance. Based on this factor structure, a test and training program (presented in the appendices) have been developed to assess and improve the physical fitness abilities of the groups involved.

Physical Fitness Performance as a Function of Physical Education Experiences

Although never conceived as a major part of the study, a part of one of the major objectives was to determine the effect of physical education experiences on physical fitness performance. In order to answer this question, it was originally planned to compare performance of persons receiving physical education with those not receiving physical education, comparing performance as a function of time spent per week for physical education, and by comparing the physical fitness performance of individuals receiving physical education from a professional physical educator with individuals receiving physical education from non-physical educators.

In order to help answer these questions, a survey was conducted relative to these questions. The survey was completed by local testers or coordinators for approximately 83 percent of the subjects involved in the study. The results appear in Table 5.1. Results indicate that 99 percent of the subjects surveyed received physical education, and that the physical education provided was almost always (99%) offered by a professional physical educator. Since this was the case, it was not considered appropriate to analyze the data in terms of physical education versus no physical education, or in terms of the effects of physical fitness performance as a function of the type of instructor.

TABLE 5.1. SURVEY RESULTS PERTAINING TO PHYSICAL EDUCATION EXPERIENCES.

Major Subject Groups	Total Number of Subjects in the Study	Number and Percent of Subjects in Survey	Number and Percent of Subjects Receiving Physical Education	Number and Percent of Subjects Taught by Professional Physical Educators	Number and Percent of Subjects X Minutes per Week of Physical Education			
					30 or less	31-60	61-90	91 or more
Normal	1192	1028 (86%)	1028 (100%)	1028 (100%)	0 (0%)	0 (0%)	171 (17%)	857 (83%)
Visual Impairment	649	575 (89%)	575 (100%)	537 (93%)	2 (0%)	3 (0%)	164 (29%)	406 (71%)
Auditory Impairment	1468	1279 (87%)	1272 (99%)	1272 (99%)	37 (03%)	14 (01%)	162 (13%)	1066 (83%)
Orthopedic Impairment	605	378 (62%)	364 (96%)	364 (96%)	88 (23%)	97 (26%)	132 (35%)	61 (16%)
Total	3914	3260 (83%)	3239 (99%)	3239 (99%)	127 (04%)	114 (04%)	629 (19%)	2390 (73%)

The results of the survey also indicated that 92 percent of the subjects in the study had physical education at least one hour per week, and 73 percent received physical education for 91 minutes or more per week. Again, in view of the relatively large percentage of individuals in these categories as opposed to those who received physical education less than one hour per week, it was considered not appropriate to analyze the data from that perspective. The data presented in Table 5.1 indicate that the offering of physical education to individuals with orthopedic impairments compared least favorably to that of other groups. Individuals with orthopedic impairments not only received physical education less often, but the physical education duration for this group was less than that for the other groups in the study. Possible explanations are that physical education is simply offered less often or that physical education is replaced by physical or occupational therapy. Unfortunately, the exploratory nature of the data collected in regard to this objective prohibits definite conclusions in regard to these questions.

In summary, although original plans called for the project to study the influence of physical education in greater depth, it was not possible to arrive at definitive answers because the subjects involved in the study were almost exclusively individuals who were receiving physical education, who were receiving physical education from a professional physical educator, and who were receiving physical education for 91 minutes or more per week. There were inadequate numbers in corresponding comparative groups. Thus, comparisons were inappropriate. Unfortunately, time and financial constraints prohibited adding additional subjects or comparative groups in this study.

Physical Fitness Test

Another very important objective of the project was to develop a valid and reliable test of physical fitness for sensory and orthopedically impaired boys and girls, between the ages of 10 and 17, on the basis of data which has been collected. In this section, the criteria for the selection of test items, the actual items selected, and information pertaining to test item validity, reliability of tests, and intercorrelations will be presented. The test is presented in its entirety in Appendix B. The test manual presented in the Appendix includes an introduction; the conceptual basis for the physical fitness test; target populations; procedures for selecting subjects for data collection; information pertaining to project coordinators and field testers who collected data; the criteria for the selection of test items; validity of test items; reliability of tests and trend analysis; intercorrelations; procedures for selecting test items for individuals; methods of determining height, weight, and age; the actual listing and description of test items and their modifications; information pertaining to norm-referenced appraisals; norms; test forms; a description of the award system associated with the test; and a bibliography of related information.

Criteria for the Selection of Test Items

Test items included in the Project UNIQUE Physical Fitness Test were selected from an original battery of 16 measures. These measures included skinfolds, sit-ups, leg raise, trunk raise, shuttle run, rise-to-stand, mat creep, modified stork test, sit and reach, grip strength, flexed arm hang, pull-ups, 50-yard/meter dash, standing broad jump, softball throw (distance and velocity), and the long distance run. The final list of test items included in the project physical fitness test was selected on the basis of both primary and secondary criteria.

The first primary criterion was to select items which were included in the AAHPER Youth Fitness Test and the AAHPERD Health Related Fitness Test. This criterion was applied so that comparisons between persons with and without handicapping conditions would be enhanced. This resulted, in a sense, in "mainstreaming" test items, so that children with handicapping conditions could take the same items as their non-impaired peers (although test procedures might be modified and score comparisons might be made with different norms). Thus, participants with handicapping conditions would not need to be separated out of a testing situation or have special test items created for them.

A second major criterion was that of validity. Test items which were finally selected were those which best measured a particular physical fitness factor. This determination was made on the basis of logical considerations, support from related literature, and factor analytic results performed with Project UNIQUE data. In selecting test items on the basis of factor analysis, the two main criteria which were applied were the size of the test's factor loading on its primary factor and the purity with which the test item measured this factor.

The third major criterion was the extent to which test items could be used for different classes of individuals. In selecting test items, preference was given to those items that could be administered to both boys and girls, could be administered to children and youth between the ages of 10 and 17 years

of age, and could be administered to both individuals with and without handicapping conditions. It must be emphasized, however, that no one item could be administered without modifications to every class of individuals. In certain cases, items had to be modified for individuals with handicapping conditions and, in other cases, it was necessary to eliminate items.

The next criterion of primary importance in the selection of test items was to select test items which had low intercorrelations. This criterion was employed so that each item in the test added new information about the ability of the participant. Test items which duplicated information were eliminated.

The final criterion of primary importance was test reliability. Other things being equal, items which were most reliable were selected for the test.

In addition to the above-mentioned primary criteria, additional secondary criteria were employed in the selection of test items. In essence, items which were selected included those which are or should be reasonably familiar to physical educators, those that require little or no expensive or elaborate equipment, and those which require a minimal amount of time to administer.

Physical Fitness Test Items

The Project UNIQUE Physical Fitness Test includes test items to measure body composition, flexibility, cardiorespiratory endurance, and factors encompassed within the rubric of muscular strength/endurance. Triceps skinfold, subscapular skinfold, and sum of triceps and subscapular skinfolds (an AAHPERD Health-Related test item) have been selected to reflect body composition in all major groups involved in the study: normal, auditory impaired, visually impaired, and the orthopedic impaired.

Muscular strength/endurance was separated into four factors or subcomponents for the purposes of the Project UNIQUE Physical Fitness Test: strength, power-strength, power-speed, and endurance. Right grip strength, left grip strength, and sum of grips (to account for possible differences in hand preference) were selected to measure the strength of normal subjects, auditory impaired subjects, visually impaired subjects, cerebral palsied girls, strength of wheelchair spinal neuromuscular subjects, and the strength of individuals classified as congenital anomaly/amputee. The grip measures were also selected to measure the power-strength of boys with cerebral palsy. No test item was selected to measure the strength factor of boys with cerebral palsy, since the grip tests loaded on the power-strength factor with this group.

The 50-yard/meter dash was selected to measure the power-speed of normal, auditory impaired, and visually impaired subjects. In addition, the 50-yard/meter dash was selected to measure power-speed of individuals with congenital anomalies/amputations. In the case of individuals with cerebral palsy and those classified as paraplegic wheelchair spinal neuromuscular, the 50-yard/meter dash was employed as a measure of power-endurance.

The sit-up test item was selected as a measure of power-strength of individuals classified as normal, auditory impaired, and visually impaired. It may be used for individuals with congenital anomalies/amputations in cases

where the sit-up is appropriate for members of these subgroups. The sit-up is not included as a test item in the case of individuals with cerebral palsy or individuals with spinal neuromuscular conditions.

The softball throw for distance is a measure of power-strength for girls with cerebral palsy and is administered, eliminated, or modified for subgroups within this group, as appropriate. (The softball throw for distance may be added for cerebral palsied boys if the tester desires to have the boys take the same items as the girls. The tester should be aware, however, that the softball throw appears to be a more valid measure of power-endurance for the boys.)

The sit and reach test was selected as a measure of flexibility for all groups of the study in which the administration of this test item is appropriate. Normal and sensory impaired subjects may always include the sit and reach test item. Individuals classified as cerebral palsied or congenital anomaly/amputee should only be administered the sit and reach item where appropriate. The sit and reach is not a test item for individuals classified as spinal neuromuscular.

The long distance "run" was selected as a test item for all individuals in the study. However, it may be necessary to modify long distance "run" procedures for all groups except the auditory impaired group and normal subjects.

Since it is not possible for certain individuals to take certain items on the basic Project UNIQUE Physical Fitness Test, certain substitutions have been recommended. The arm hang test is suggested as a substitute for the grip strength test to measure power-strength in the case of boys with cerebral palsy. The arm hang test is also a suggested substitute measure of strength for paraplegic wheelchair spinal neuromuscular boys and for boys classified as congenital anomaly/amputee. The softball throw for distance may be substituted for the grip strength test to measure strength in the case of boys and girls classified as paraplegic wheelchair spinal neuromuscular. In addition, the softball throw for distance item, in which subjects are seated, may be substituted for the sit-up as a measure of power-strength in the case of boys and girls classified as congenital anomaly/amputee where the sit-up is not appropriate as a test item.

The broad jump is suggested as a substitute measure of strength for grip strength measures in the case of subjects identified as normal, auditory impaired, and visually impaired. In addition, the broad jump may be substituted for the arm hang or grip strength test as a strength measure for those individuals with congenital anomalies/amputations who may have upper limb involvement but able-bodied lower extremities. Test items by major groups and physical fitness components are presented in Tables 5.2 and 5.3.

Reliability of Test Items

The reliability of Project UNIQUE Physical Fitness Test items has been determined through the research of Daquila (1982) using Project UNIQUE data and information which has been found in related research. This information is presented in detail in Chapter 2. In this section, information pertaining to the reliability of items selected for the Project UNIQUE Physical Fitness Test is summarized.

TABLE 5.2. PROJECT UNIQUE PHYSICAL FITNESS TEST FOR NORMAL, SENSORY IMPAIRED, AND ORTHOPEDICALLY IMPAIRED CHILDREN AND YOUTH: COMPONENTS AND TEST ITEMS.

Component/Factor	Basic Test Item	Comments
Body Composition	Triceps Skinfold Subscapular Skinfold Sum of Triceps and Subscapular Skinfolds	Skinfold test items are administered to all subject groups except in cases where inappropriate due to congenital anomaly or amputation.
Muscular Strength/ Endurance		
Strength or Power-Strength	Right Grip Left Grip Sum of Grips	The grip measures are administered to all subject groups except in cases where inappropriate due to physical condition. The grip tests are used as a measure of the strength factor in subject groups except boys with cerebral palsy. The grip tests are used as a measure of power-strength for boys with cerebral palsy.
Power-Speed or Power-Endurance	50-Yard/Meter Dash	The 50-yard/meter dash is administered to all subject groups except where inappropriate due to physical condition. Procedures for the dash are modified for certain subject groups. The dash is used as a measure of power-speed for all groups except the cerebral palsy and spinal neuromuscular groups. Relative to these groups, the dash is a measure of power-endurance.
Power-Strength	Sit-Ups	The sit-up is administered as a measure of power-strength to all major subject groups except the cerebral palsy group and spinal neuromuscular groups. In the case of individuals with congenital anomalies/amputees, it may be necessary to eliminate or modify the test for certain subgroups or substitute the softball throw for distance as a measure of power-strength.

TABLE 5.2. (cont.)

Component/Factor	Basic Test Test Item	Comments
Muscular Strength/ Endurance		
Power-Strength	Softball Throw	The softball throw for distance is a measure of power-strength for girls with cerebral palsy and is administered, eliminated, or modified for subgroups, as appropriate.
Flexibility	Sit and Reach	The sit and reach test is administered as a measure of flexibility to normal and sensory impaired groups. It is a test item not administered to individuals with spinal neuromuscular conditions and, although administered to other orthopedically impaired groups, may require modification or elimination in certain orthopedic subgroups.
Cardiorespiratory Endurance	Long Distance Run	The long distance run is administered to all groups. In certain instances, there is a need to modify procedures.
	Substitutions	
Strength	Broad Jump	The broad jump is a substitute item for grip tests in the following groups: normal, auditory impaired, visually impaired, congenital anomaly/ amputee (as appropriate).
Strength or Power-Strength	Arm Hang	The arm hang is a substitute test item for grip tests for boys with cerebral palsy, paraplegic wheelchair spinal neuromuscular boys, and boys classified as congenital anomaly/ amputee (as appropriate). In the case of boys with cerebral palsy, the arm hang is a measure of power-strength.

TABLE 5.2. (cont.)

Component/Factor	Substitutions Test Item	Comments
Strength or Power-Strength	Softball Throw for Distance	The softball throw for distance may be substituted as a measure of power-strength for individuals classified as congenital anomaly/amputee. It is used as a substitute measure of strength in the case of paraplegic wheelchair spinal neuromuscular subjects.

TABLE 5.3. PROJECT UNIQUE PHYSICAL FITNESS TEST ITEMS X MAJOR SUBJECT GROUPS.

Subject Group	Test Items*
Normal, Auditory Impaired, and Visually Impaired	Basic Test: body composition: triceps skinfold, subscapular skinfold, sum of triceps and subscapular skinfolds; strength: right grip, left grip, sum of grips; power-speed: 50-yard/meter dash; power-strength: sit-ups; flexibility: sit and reach; cardiorespiratory endurance: long distance run. Substitutions: The broad jump may be substituted for grip strength tests as a measure of strength.
Cerebral Palsy	Basic Test: The basic test includes the same items as recommended for normal individuals except that the sit-up test is eliminated and girls substitute the softball throw for distance as a measure of power-strength. The 50-yard/meter dash is a measure of power-endurance. In the case of cerebral palsy boys, grip tests are measures of power-strength. Substitutions: The arm hang may be substituted for grip tests as measures of power-strength for boys.
Paraplegic Wheelchair Spinal Neuromuscular	Basic Test: The basic test includes the same items as recommended for normal individuals except that the sit-up and sit and reach tests are eliminated. The 50-yard/meter dash is used as a measure of power-endurance. Substitutions: The arm hang or softball throw for distance may be substituted for grip strength measures (strength factor) for male subjects. The softball throw may be substituted for grip strength measures (strength factor) for female subjects.
Congenital Anomaly/Amputee	Basic Test: The basic test items for this group are the same as for normal subjects. Substitutions: As a substitute for grip tests, boys may substitute the broad jump or arm hang and girls may substitute the broad jump as measures of the strength factor, as appropriate. The softball throw for distance may be substituted for sit-ups (as a power-strength factor) in cases where the sit-up would be considered inappropriate.

*In certain cases, test items may be modified for particular groups and be eliminated for subgroups within groups when the administration of a particular test item would be inappropriate.

Daquila (1982), analyzing Project UNIQUE data in an unpublished master's thesis, determined the test reliability, as represented by alpha coefficients, of the following test items: skinfold measurements, sit and reach, grip strength test items, flexed arm hang, broad jump, and softball throw for distance. To determine alpha coefficients, Daquila randomly selected 50 Project UNIQUE subjects from each of the major subject categories (normal, auditory impaired, visually impaired, and orthopedically impaired). The results of Daquila's work is included in Table 5.4 relative to test items selected for the Project UNIQUE Physical Fitness Test and also is presented in Chapter II in greater detail.

In addition to Daquila's research, information pertaining to the reliability of these test items was reviewed in related research and literature and is presented in summary form in Table 5.4. In the case of sit-ups, the 50-yard/meter dash, and the long distance run, reliability coefficients were summarized from related research because Daquila's study did not include these test items. These results are also presented in Table 5.4. The results presented in Table 5.4 indicate that reliability coefficients pertaining to tests selected for the Project UNIQUE Physical Fitness Test are high. The alpha coefficients found by Daquila were, in general, superior to those found in other studies for similar items. Brief review of this table will indicate very acceptable reliability coefficients.

Specifically, in regard to skinfold measures, reliability coefficients reported by Colgan (1978) and Daquila (1982) are .90 or above. AAHPERD (1980) has reported that test-retest correlation coefficients associated with skinfold tests have exceeded .95 in experienced testers.

In regard to test items measuring factors related to muscular strength/endurance, reliability have also been very acceptable. In regard to grip strength tests, within day reliability coefficients are generally in the .80's and .90's. Daquila (1982) reported alpha coefficients of .97 or better. Flexed arm hang reliability coefficients are generally high, i.e., generally in the high .80's and .90's. These reliability coefficients were found by Vodola (1978), Bolonchuk (1971), Colgan (1978), and Avent (1963). Daquila, using Project UNIQUE data, reported reliability coefficients pertaining to the flexed arm hang ranging from .84, in the case of the visually impaired subjects, to .96 for subjects classified as orthopedically impaired. The standing long jump or broad jump has been studied by several investigators. A review of Table 5.4 will indicate very acceptable reliability coefficients in regard to the standing long jump. Daquila (1982), using Project UNIQUE data, found reliability coefficients of .94 or above in all major subject groups in which he administered three trials. The reliability of the softball throw for distance test has been studied by Fleishman (1964b), Klesius (1968), Marmis, et al. (1969), Keogh (1965), and Bolonchuk (1971). Reliability coefficients in these studies were relatively high, ranging from .83 to .99, with most coefficients above .90. Daquila (1982), using Project UNIQUE data, found the alpha coefficients ranging from .86 for orthopedically impaired subjects to as high as .99 in groups identified as visually impaired and auditory impaired. In regard to sit-ups, Vodola (1978) reported reliability coefficients ranging from .89 to .99 in the various groups which he studied. Klesius (1968) reported some of the lowest reliability coefficients in the literature. His reliability coefficients range from .68 to .94 (AAHPERD, 1980). In regard to the 50-yard dash,

TABLE 5.4. RELIABILITY COEFFICIENTS OF PROJECT UNIQUE PHYSICAL FITNESS TEST ITEMS.*

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Skinfold Measurements	Colgan (1978)	between day, test-retest correlation coefficients	1t - 2d 1 week apart	164 males and 162 females ages 10-18	Triceps: .93f .96m Subscapular: .94f .90m
Triceps, Subscapular, and Abdominal Skinfolds	Daquila (1982)	within day, test-retest alpha coefficients for triceps, abdominal, and subscapular measures	3t - 1d for all groups	50 normal males and females ages 10-17	.99 (all sites)
				50 visually impaired males and females ages 10-17	.90-.99
				50 auditory impaired males and females ages 10-17	.98-.99
				50 orthopedically impaired males and females ages 10-17	.97-.99
Grip Strength	Fleishman (1964b)	test-retest correlation coefficients	not given	20,000 males and females ages 12-18	.91
					Rt / Lft.
	Rarick, Dobbins, & Broadhead (1976)	within day, test-retest correlation coefficients	3t	71 males ages 6-9	.911 / .959
				65 retarded males ages 10-13	.927 / .941
				71 retarded males ages 6-9	.902 / .917
				74 females ages 6-9	.882 / .896
				61 retarded females ages 10-13	.975 / .959
				64 retarded females ages 6-9	.917 / .934

*The information presented in this table was summarized by the authors and depends heavily on Daquila, Gene A. "Reliability of Selected Health and Performance Related Test Items from the Project UNIQUE Physical Fitness Test Inventory," Unpublished Master's Thesis, SUNY College at Brockport, 1982.

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef. Rt.	Rel. Coef. Lft.
Grip Strength (cont.)	Keogh (1965)	Pearson product-moment, test-retest	2t - 2d 2-6 weeks apart	23 1st grade males and females	.85	.79
				23 3rd grade males and females	.75	.70
	Keogh (1965)	within day, Pearson product-moment, test-retest	2t	23 1st grade males and females	.76 (right hand only)	
				23 3rd grade males and females	.84 (right hand only)	
	Avent (1963)	between day, test-retest, Pearson product-moment	2t - 2d 3-8 weeks apart	50 females ages 9-12	.654	.797
	Daquila (1982)	within day, test-retest alpha coefficients	3t - 1d (alternating R/L)	50 normal males and females ages 10-17	.98	.98
				50 visually impaired males and females ages 10-17	.99	.97
				50 auditory impaired males and females ages 10-17	.97	.98
				50 orthopedically impaired males and females ages 10-17	.98	.99
Flexed Arm Hang	Vodola (1978)	between day, test-retest, Pearson product-moment	one day between tests	30 females age 15	.97	
				33 males age 15	.89	
				19 females age 7	.88	
	Bolonchuk (1971)	test-retest, Pearson product-moment	2t	25 5th and 6th grade females	.95	

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Flexed Arm Hang (cont.)	Colgan (1978)	between day, test-retest correlation coefficients	1t - 2d 1 week apart	164 males and 162 females ages 10-18	.96m .89f
	Avent (1963)	between day, test-retest, Pearson product-moment	2t - 2d 3-8 weeks apart (underhand grip used)	50 females ages 9-12	.868
	Daquila (1982)	within day, test-retest alpha coefficients	2t - 1d	50 normal males and females ages 10-17	.93
				50 visually impaired males and females ages 10-17	.84
				50 auditory impaired males and females ages 10-17	.92
				50 orthopedically impaired males and females ages 10-17	.96
Standing Broad Jump	Klesius (1968)	within day, test-retest correlation coefficients between trials	3t	150 10th grade males	.82-.88
	Marmis, et al. (1969)	within day, test-retest correlation coefficients	3t	1,122 males ages 9-18 938 females ages 9-18	.73-.95 .75-.95
	Vodola (1978)	between day, test-retest, Pearson product-moment	one day between tests	30 females age 15 33 males age 15 13 males age 6 19 females age 7	.95 .98 .49 .89

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Standing Broad Jump (cont.)	Rarick, Dobbins, & Broadhead (1976)	within day, test-retest correlation coefficients	4t	71 males ages 6-9	.805
				65 retarded males ages 10-13	.917
				71 retarded males ages 6-9	.947
				74 females ages 6-9	.906
				61 retarded females ages 10-13	.953
				64 retarded females ages 6-9	.957
	Kane & Meredith (1952)	within day, test-retest, Pearson product-moment	12t (best trial and second best trial)	300 males ages 7, 9, 11	.97-.99
				300 females ages 7, 9, 11	.98-.99
	Kane & Meredith (1952)	between day, test-retest, Pearson product-moment	12t - 2d (best score on both days)	75 males age 7	.83
				75 females age 7	.86
	Keogh (1965)	between day, test-retest, Pearson product-moment	3t - 2d 2-6 weeks apart	21 1st grade males & females	.90
				27 3rd grade males & females	.77
	Keogh (1965)	within day, test-retest, Pearson product-moment	3t (best and second best used)	Not given	.91
	Baumgartner & Jackson (1970)	test-retest, ANOVA procedure (intraclass correlation)	best trial grouping from 6 trials	95 Junior-high males	.96
				82 Senior-high males	.97
	Bolonchuk (1971)	Pearson product-moment, test-retest	3t	20 5th & 6th grade males	.89
				25 5th & 6th grade females	.82

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Standing Broad Jump (cont.)	Avent (1963)	between day, test-retest, Pearson product-moment	3t - 2d 3-8 weeks apart	50 females ages 9-12	.681
	Anhalt (1958)	between day, test-retest, Pearson product-moment	3t - 2d 1 week apart	32 4th-5th-6th grade females	.913
	Colgan (1978)	between day, test-retest correlation coefficients	1t - 2d 1 week apart	164 males ages 10-18 162 females ages 10-18	.81m .82f
	Daquila (1982)	within day, test-retest (alpha coefficients)	3t - 1d	50 normal males and females ages 10-17	.96
				50 visually impaired males and females ages 10-17	.94
				50 auditory impaired males and females ages 10-17	.98
				21 orthopedically impaired males and females ages 10-17	.99
Softball Throw (Distance)	Fleishman (1964b)	test-retest, correlation coefficients	not given	20,000 males and females ages 12-18	.93
	Klesius (1968)	within day, test-retest correlation coefficients between trials	3t	150 10th grade males	.90-.94

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Softball Throw (Distance) (cont.)	Marmis, et al. (1969)	test-retest, correlation coefficients	3t	1,122 males ages 9-18 938 females ages 9-18	.86-.94 .83-.97
	Keogh (1965)	Pearson product-moment, between day, test-retest	3t - 2d 2-6 weeks apart	10 1st grade males & females 27 3rd grade males & females	.97 .88
	Bolonchuk (1971)	test-retest, Pearson product-moment	3t	20 5th & 6th grade males 25 5th & 6th grade females	.94 .93
	Daquila (1982)	within day, test-retest alpha coefficients	3t - 1d	50 normal males and females ages 10-17 50 visually impaired males and females ages 10-17 50 auditory impaired males and females ages 10-17 50 orthopedically impaired males and females ages 10-17	.95 .99 .99 .86
Sit-Ups	Vodola (1978)	test-retest, between day, Pearson product-moment	1t - 2d	30 females age 15 33 males age 15 10 males age 7	.99 .90 .89
	Klesius (1968)	test-retest correlation coefficients between trials	1t - 2d 1 day between trials	150 10th grade males	.55-.68
	Colgan (1978)	between day, test-retest, correlation coefficients	1t - 2d 1 week apart	164 males ages 10-18 162 females ages 10-18	.80m .84f

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
50-Yard Dash	Klesius (1968)	test-retest, correlation coefficients between trials	3t	150 10th grade males	.83-.88
	Jackson & Baumgartner (1969)	test-retest ANOVA Procedures (intraclass correlation)	2t - 1d	76 male physical education majors	.949
	Colgan (1978)	between day, test-retest correlation coefficients	1t - 2d 1 week apart	164 males ages 10-18 162 females ages 10-18	.94m .88f
Sit and Reach	Colgan (1978)	between day, test-retest	1t - 2d 1 week apart	164 males ages 10-18 162 females ages 10-18	.84m .95f
	Daquila (1982)	within day, test-retest (alpha coefficients)	2t - 1d	50 normal males and females ages 10-17	.99
				50 visually impaired males and females ages 10-17	.98
				50 auditory impaired males and females ages 10-17	.99
				38 orthopedically impaired males and females ages 10-17	.99
Long Distance Run	Kodola (1978)	test-retest, between day Pearson product-moment	1t - 2d	90 males and females ages 14-17	.80
	Doolittle & Bigbee (1968)	test-retest, Pearson product-moment	1t - 2d 5 days apart	153 9th grade males	.94

TABLE 5.4. (cont.)

Item	Source	Procedure	Trials (t) Days (d)	Sample	Rel. Coef.
Long Distance Run (cont.)	Doolittle, Dominic, & Doolittle (1969)	test-retest	1t - 2d	100 9th-10th grade females 45 9th grade females	.89 .89
Mile Run	Colgan (1978)	between day, test-retest correlation coefficients	1t - 2d 1 week apart	164 males ages 10-18 162 females ages 10-18	.96m .87f

Jackson and Baumgartner (1969) reported an intraclass reliability coefficient of .949, Colgan (1978) reported correlation coefficients of .88 (females) and .94 (males), and Klesius (1968) reported correlation coefficients in the .80's.

The sit and reach has been studied by Colgan (1978). Colgan (1978) reported reliability coefficients of .84 for male subjects and .95 for female subjects. Daquila, using Project UNIQUE data, reported extremely high correlation coefficients. Daquila (1982) reported alpha coefficients of .98 and .99 in the various major groups studied in Project UNIQUE. AAHPERD (1980) has reported reliability coefficients of .70 or above in summarizing research pertaining to the sit and reach test.

Based on the research of Colgan (1978); Vodola (1978); Doolittle and Bigbee (1968); and Doolittle, Dominic, and Doolittle (1969), reliability coefficients for long distance runs are generally high (.80 to .96).

Validity

The validity of test items for the Project UNIQUE Physical Fitness Test was determined in consideration of construct validity, criterion related validity, and logical validity. Construct validity was established as a part of Project UNIQUE and consisted of a factor analysis of test items in consideration of the various groups involved in the project. The results of this study will be presented first in this section. Construct, criterion related, and logical validity have also been determined on the basis of related literature and research and is presented in the second portion of this section.

The principal component factor loadings (orthogonal solutions) pertaining to the test items selected for each group on the Project UNIQUE Physical Fitness Test are presented in Table 5.5. In Chapter IV, more detailed information is presented pertaining to factor structure. In Chapter IV, Principal Component (PC), Rao Canonical (RAO), and alpha factoring are presented for orthogonal and oblique solutions for males and females using raw score as well as residual matrices for the major subject groups in the study.

As may be noted from Table 5.5, the inclusion of recommended test items is generally supported by the obtained factor loadings. Factor loadings are high for most recommended items. This is particularly true of primary items as opposed to substitute items. Loadings for the skinfold measures, as representative of body composition, are very high (.80 or above). The inclusion of the 50-yard dash appears justified as a measure of power-speed for normal and sensory impaired subjects based on factor loadings which fall between .65 and .83. The inclusion of the dash as a measure of power-endurance for orthopedically impaired subjects is supported by factor loadings ranging from .53 to .90. The sit-up test is recommended as a power-strength measure for normal and sensory impaired subjects. The data in Table 5.5 generally would seem to support this decision for boys, as four out of the six loadings are at .54 or higher. The inclusion of sit-ups for girls is not supported by the data in Table 5.5; however, this item is also recommended for girls because it is an AAHPERD Health Related Physical Fitness Test item for girls and it generally loaded on other power-related components in the factor analysis. For cerebral palsied girls, the softball throw is recommended as an indicator of power-strength (.64-.69). Grip strength is selected to represent the power-strength component for cerebral

TABLE 5.5. PRINCIPAL COMPONENT FACTOR LOADINGS (ORTHOGONAL SOLUTIONS) ON PROJECT UNIQUE PHYSICAL FITNESS TEST ITEMS.

Component/ Factor	Test Item	Principal Component Raw Score Matrix			Principal Component Residual Matrix		
		Female	Male	Combined	Female	Male	Combined
Body Composition	Triceps Skinfold						
	A	.88	.81		.89	.81	
	B	.82	.82		.81	.84	
	C	.86	.83		.86	.84	
	D	.91	.90		.94	.96	
	E			.82			.80
	Subscapular Skinfold						
	A	.84	.86		.84	.83	
	B	.86	.86		.85	.85	
	C	.87	.89		.87	.89	
	D	.91	.83		.88	.84	
	E			.88			.89
Muscular Strength/ Endurance							
Power-Speed	50-Yard Dash						
	A	.72	.65		.66	.83	
	B	.69	.72		.69	.79	
	C	.77	.73		.77	.71	
Power-Endurance	D	.53	.89		.68	.90	
	E			.82			.83
Power-Strength	Sit-Ups						
	A	-	-		-	.60	
	B	-	.54		-	-	
	C	-	.56		-	.54	
	Softball Throw (Distance)						
	D	.64			.69		
	Right Grip						
	D		.60			-	
	Left Grip						
	D		.71			.49	

(continued)

Legend: A - Normal Subjects
B - Auditory Impaired Subjects
C - Visually Impaired Subjects
D - Cerebral Palsied Subjects
E - Wheelchair Paraplegic Spinal Neuromuscular Subjects

TABLE 5.5. (cont.)

Factor	Test Item	Principal Component Raw Score Matrix			Principal Component Residual Matrix		
		Female	Male	Combined	Female	Male	Combined
Power-Strength (cont.)	Arm Hang*						
	D		.78			.77	
Strength	Right Grip						
	A	.93	.91		.95	.90	
	B	.94	.91		.94	.93	
	C	.85	.82		.90	.84	
	D	.89			.82		
	E			.79			.83
	Left Grip						
	A	.87	.93		.85	.91	
	B	.91	.87		.91	.85	
	C	.84	.85		.84	.91	
	D	.85			.74		
	E			.80			.79
	Arm Hang*						
	E			.58			.65
	Softball* Throw (Distance)						
	E			.61			.63
	Broad Jump*						
	A	-	.65		-	-	
	B	.49	.68		.45	.42	
	C	-	-		-	-	

*recommended as a substitute item

Legend: A - Normal Subjects
B - Auditory Impaired Subjects
C - Visually Impaired Subjects
D - Cerebral Palsied Subjects
E - Wheelchair Paraplegic Spinal Neuromuscular Subjects

TABLE 5.6. FACTOR LABELS BY GROUPS.

Factor	Normal		Auditory Impaired		Visually Impaired		Cerebral Palsy		Paraplegic/ Spinal Neuro-muscular Wheelchair
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	
Body Composition	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
Strength	(X)	(X)	(X)	(X)	(X)	(X)	(X)		(X)
Power-Speed	(X)	(X)	(X)	(X)	(X)	(X)			(X)
Power-Strength	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	
Power-Endurance				( )			(X,X)	(X)	
Flexibility/ Power-Endurance	X		(X)		(X)				
Leg Raise								(X)	

X - raw score matrix

( ) - residual matrix

palsied boys (three of the four loadings are .49 or higher). The grip strengths are recommended as measures of strength for all other groups of subjects (.74-.95). The use of the arm hang, softball throw for distance, and broad jump as measures of strength or power-strength is less defensible as determined by factor loadings and, consequently, are recommended as substitute items only.

In addition to the components of the Project UNIQUE Physical Fitness Test presented in Table 5.5, cardiorespiratory endurance and flexibility are components included within the test. The long distance run and the sit and reach test were selected to measure these components of physical fitness. The factor analysis employed in this study did not identify separate factors of flexibility and cardiorespiratory endurance. This could be due to the fact that only one test item was used to define each of these factors. With no other items hypothetically related to these constructs, it became especially difficult to extract these factors from the data. The fact that flexibility and cardiorespiratory endurance did not clearly emerge, therefore, was due, to a large extent, to the absence of other items which may have helped to better define these constructs. The items which comprise flexibility (sit and reach) and cardiorespiratory endurance (long distance run) did load, to some extent, on other factors. The sit and reach test emerged for normal, auditory, and visually impaired girls on each factor which included the trunk raise and leg raise. It was suggested that the emergence of this factor was due to flexibility components. The long distance run item loaded either on the power-speed or power-strength factors. In addition to the cardiorespiratory demands of the test, the long distance run makes demands on the muscular system as well. This is apparently a reason why the long distance run loaded on power-related factors, particularly in the absence of other cardiorespiratory items in the design. In the final analysis, the flexibility and cardiorespiratory components were not supported or unsupported by the physical fitness factor analysis conducted in this study. Thus, they are selected and justified on the basis of past research and logic. Detailed information on the factor structure of test items studied in Project UNIQUE is presented in Chapter IV.

In addition to the factor analytic information presented in connection with Project UNIQUE data, justification for the selection of test items, in terms of validity, may be found from related literature and research. In regard to items pertaining to muscular strength/endurance, the validity of the grip strength test as a measure of strength has been supported by studies by Rarick, Dobbins, and Broadhead (1976) and Fleishman (1964a, 1964b). Flint (1965), using electromyographic techniques, showed that the bent-knee sit-ups involves action of the abdominal muscles, including the upper and lower rectus abdominus and the external and internal obliques. On the basis of her review of research, Safrit (1981) has reported that the standing broad jump has generally been accepted as an adequate measure of muscular power.

In regard to the softball throw for distance, the literature is less supportive. In regard to softball velocity as a test item, Rarick, Dobbins, and Broadhead (1976) found that it was correlated moderately with the standing long jump (.54 to .71) and the vertical jump (.51 to .62). Rarick, Dobbins, and Broadhead (1976) also indicated that the time dimension more accurately reflected the actual force applied to the ball than using distance information only. In collecting Project UNIQUE data, however, it was found to be extremely difficult to measure time of throw and to determine the height of release. In addition, computation of velocity in a field setting is much more laborious

than simply recording distance. Also, a reasonably high correlation was found between softball throw for distance and softball throw for velocity using Project UNIQUE data. Thus, the softball throw for distance was selected in preference to softball throw for velocity. Previous research by other investigators have warned about the relatively lower performance of visually handicapped youngsters in the softball throw and attribute this to a learning factor. In view of this related research, softball throw for distance was not employed as a test item for visually impaired subjects. However, it was offered as an alternative in the case of girls with cerebral palsy and individuals with congenital anomalies who exhibited upper limb disabilities and who were required to throw from a seated position.

The 50-yard/meter dash was selected primarily on the basis of a logical consideration and the result of factor analysis of Project UNIQUE data. It has, in the past, been often selected as a speed item in notable tests of physical fitness. In regard to the flexed arm hang, Cotton and Marwitz (1969) found a correlation coefficient of .72 between the flexed arm hang and the pull-up test. The disadvantage of the flexed arm hang as a test item appears to be the fact that it is affected by one's weight. Because of this and some other considerations, it is only suggested as an alternative item for boys with cerebral palsy, boys in the spinal neuromuscular groups, and for individuals with congenital anomalies/amputations who exhibit lower extremity involvement, but who are unable to, for one reason or another, take the grip strength tests.

Height and weight have long been used as an indicator of body composition; however, it has been well established that these measures fail to appropriately take into account fatness/leanness. In view of this, hydrostatic weighing has been employed to more accurately determine body composition, and skinfold measures have been used to predict body composition. Coefficients of correlation have ranged from .70 to .90 when skinfolds have been correlated with hydrostatic weighing (AAHPERD, 1980).

The sit and reach test has been employed in the Project UNIQUE Physical Fitness Test as a measure of extensibility in the low back and posterior thighs and has been labeled a flexibility test item. It has been reported that the sit and reach test has correlated highly (.80 to .90) with other tests of flexibility (AAHPERD, 1980). However, since flexibility is known to be specific to particular areas of the body, validity of this test depends more on a logical basis than its relationship to criterion measures.

Although laboratory tests of aerobic capacity are preferred measures of cardiorespiratory endurance, such tests are limited for use in field situations. Therefore, distance runs of up to 12 minutes have been studied to determine their relationship with the results of laboratory tests of aerobic capacity. The results of research indicate that long distance runs have correlated well with laboratory tests (AAHPERD, 1980).

Intercorrelations

One of the criteria that was employed in the selection of test items was that intercorrelations of test items be low. When this is the case, a single test item provides more predictive information than when this is not the case. Low intercorrelations among test items is enhanced when test items

selected are found to measure different factors. The selection of test items with low intercorrelations was enhanced by the factor analysis procedures employed in this study. The fact that this criterion was satisfactorily met in selection of items for the Project UNIQUE Physical Fitness Test is demonstrated by the relatively low intercorrelations presented in Table 5.7.

TABLE 5.7. INTERCORRELATIONS OF TEST ITEMS BY MAJOR SUBJECT GROUPS.

Test Item and Group	Triceps Skinfold	Subscapular Skinfold	Right Grip	Left Grip	Arm Hang	Broad Jump	Softball Distance	Sit-ups	50-Yard Dash	Sit and Reach	Long Distance Run
Triceps Skinfold											
A*	-	.75	-.15	-.14	-.32	-.26	-	-.24	.25	.00	-.37
b*	-	.73	-.11	-.12	-.25	-.30	-	-.24	.23	.08	-.30
C*	-	.75	.00	-.00	-.32	-.30	-	-.18	.24	.02	-.25
D*	-	.78	.17	-.05	-.19	-	-.15	-	-.04	-	.20
E*	-	.82	.41	.35	-.10	-	-.02	-	-.03	-	.03
Subscapular Skinfold											
A	.75	-	-.02	-.04	-.35	-.27	-	-.27	.31	-.03	.30
B	.73	-	.06	.06	-.29	-.22	-	-.25	.22	.07	-.26
C	.75	-	.15	.15	-.29	-.18	-	-.16	.12	.01	-.22
D	.78	-	.17	.07	-.35	-	-.06	-	.02	-	-.11
E	.82	-	.47	.44	-.08	-	.16	-	.09	-	-.12
Right Grip											
A	-.15	-.02	-	.95	.38	.66	-	.46	-.60	.04	.47
B	-.11	.06	-	.94	.31	.69	-	.37	-.52	.18	.36
C	.00	.15	-	.93	.32	.64	-	.45	-.49	.14	.37
D	.17	.17	-	.78	.06	-	.20	-	.23	-	.14
E	.41	.47	-	.91	.14	-	.57	-	-.11	-	.29
Left Grip											
A	-.14	-.04	.95	-	.40	.67	-	.48	-.60	.04	[illegible]
B	-.12	.06	.94	-	.30	.66	-	.35	-.51	.16	.33
C	-.00	.15	.93	-	.34	.63	-	.44	-.51	.15	.38
D	-.05	.07	.78	-	.08	-	.33	-	.21	-	.18
E	.35	.44	.91	-	.24	-	.59	-	-.12	-	.20

*Legend: A - coefficients of correlation pertaining to normal subjects
B - coefficients of correlation pertaining to auditory impaired subjects
C - coefficients of correlation pertaining to visually impaired subjects
D - coefficients of correlation pertaining to cerebral palsied subjects
E - coefficients of correlation pertaining to paraplegic wheelchair spinal neuromuscular subjects

TABLE 5.7. (cont.)

Test Item and Group	Triceps Skin-fold	Subscap-ular Skin-fold	Right Grip	Left Grip	Arm Hang	Broad Jump	Soft-ball Dis-tance	Sit-ups	50-Yard Dash	Sit and Reach	Long Distance Run
Arm Hang											
A*	-.32	-.35	.38	.40	-	.51	-	.50	-.47	.02	.52
B*	-.25	-.29	.31	.30	-	.52	-	.46	-.37	.13	.49
C*	-.32	-.29	.32	.34	-	.50	-	.41	-.33	.14	.44
D*	-.19	-.35	.06	.08	-	-	.25	-	-.05	-	.41
E*	-.10	-.08	.14	.24	-	-	.50	-	.07	-	.12
Broad Jump											
A	-.26	-.27	.66	.67	.51	-	-	.57	-.71	.07	.55
B	-.30	-.22	.69	.66	.52	-	-	.52	-.59	.26	.52
C	-.30	-.18	.64	.63	.50	-	-	.59	-.70	.20	.58
D	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	-
Softball Distance											
A	-	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	-	-
C	-	-	-	-	-	-	-	-	-	-	-
D	-.15	-.06	.20	.33	.25	-	-	-	-.42	-	.49
E	-.02	.16	.57	.59	-.35	-	-	-	-.35	-	.44
Sit-Ups											
A	-.24	-.27	.46	.48	.50	.57	-	-	-.63	.07	.55
B	-.24	-.25	.37	.35	.46	.52	-	-	-.51	.22	.48
C	-.18	-.16	.45	.44	.41	.59	-	-	-.43	.20	.56
D	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	-

*Legend: A - coefficients of correlation pertaining to normal subjects
B - coefficients of correlation pertaining to auditory impaired subjects
C - coefficients of correlation pertaining to visually impaired subjects
D - coefficients of correlation pertaining to cerebral palsied subjects
E - coefficients of correlation pertaining to paraplegic wheelchair spinal neuromuscular subjects

TABLE 5.7. (cont.)

Test Item and Group	Triceps Skin-fold	Subscap-ular Skin-fold	Right Grip	Left Grip	Arm Hang	Broad Jump	Soft-ball Dis-tance	Sit-ups	50-Yard Dash	Sit and Reach	Long Distance Run
50-Yard Dash											
A*	.25	.31	-.60	-.60	-.47	-.71	-	-.63	-	-.08	-.58
B*	.23	.22	-.52	-.51	-.37	-.59	-	-.51	-	-.21	-.34
C*	.24	.12	-.49	-.51	-.33	-.70	-	-.43	-	-.16	-.49
D*	-.04	.02	.23	.21	-.05	-	-.42	-	-	-	-.36
E*	-.03	.09	-.11	-.12	.07	-	-.35	-	-	-	-.49
Sit and Reach											
A	.00	-.03	.04	.04	.02	.07	-	.07	-.08	-	.04
B	.08	.07	.18	.16	.13	.26	-	.22	-.21	-	.05
C	.02	.01	.14	.15	.14	.20	-	.20	-.16	-	.11
D	-	-	-	-	-	-	-	-	-	-	-
E	-	-	-	-	-	-	-	-	-	-	-
Long Distance Run (Yards/Min.)											
A	-.37	.30	.47	.48	.52	.55	-	.55	.58	.04	-
B	-.30	-.26	.36	.33	.49	.52	-	.48	-.34	.05	-
C	-.25	-.22	.37	.38	.44	.58	-	.56	-.49	.11	-
D	.20	-.11	.14	.18	.41	-	.49	-	-.36	-	-
E	.03	-.12	.29	.20	.12	-	.44	-	-.49	-	-

*Legend: A - coefficients of correlation pertaining to normal subjects
B - coefficients of correlation pertaining to auditory impaired subjects
C - coefficients of correlation pertaining to visually impaired subjects
D - coefficients of correlation pertaining to cerebral palsied subjects
E - coefficients of correlation pertaining to paraplegic wheelchair spinal neuromuscular subjects

Curricular Implications

One of the objectives of Project UNIQUE was to identify curricular implications pertaining to physical fitness development of individuals with sensory and orthopedic impairments. In relationship to this objective, the development of a valid and reliable test of physical fitness is an important implication and has been discussed and presented in the previous section. In this part, additional implications will be presented. In essence, the curricular implications to be presented pertain to (1) commonality of factor structure, (2) levels of physical fitness, (3) type and severity of handicapping condition, (4) age, (5) sex differences, (6) educational setting, (7) individualization, (8) educational responsibility, and (9) training materials.

Commonality of Factor Structure

Within the limitations of this study, it is clear that the factor structure of physical fitness of sensory or orthopedically impaired children and youth does not differ, to a great extent, from that identified for normal individuals. The fact that the factor structure of physical fitness abilities is similar means that the general curricular orientation pertaining to physical fitness may be similar. For all groups, attention needs to be given to body composition, muscular strength/endurance, flexibility, and cardiorespiratory endurance. In cases where satisfactory performance exists, attention must be given to maintaining and improving these components of fitness. Where deficits exist, attention should be given to bringing individuals to appropriate levels.

Levels of Physical Fitness

Although the factor structure of physical fitness is similar for all the major groups involved in the study, there is little question that individuals with handicapping conditions generally fall below the performance of individuals classified as normal. An implication of this finding is that it is necessary, at times, to begin physical fitness development programs for the handicapped at very basic levels. In certain instances, it will be necessary to prepare individuals to move through the environment. This may begin with the simple task of moving from a lying to a standing position or maintaining standing balance. Following this beginning, attention can then be given to helping the individual move through the environment. Subsequently, attention can be given to sustaining movement through the environment. Once the individual has the basic physical fitness necessary to move through the environment for relatively sustained periods of time, attention can be given to quality of movement, increasing the repertoire of movement capabilities, and enhancing optimal development of the individual. Although individuals low in fitness may need to engage in less intense activities at the beginning levels of programming, provisions may need to be made to increase the frequency of opportunities to move and to move for relatively longer periods of time. The latter two adjustments may be required to compensate for the lower intensity of programs.

Influence of Handicapping Conditions and Severity of Handicapping Conditions

The results of the study clearly indicate physical fitness differences between subjects with handicapping conditions and normal subjects. In the case of auditory impaired subjects, differences with normal subjects were less in

degree and number than in the case of other groups. In terms of physical fitness, individuals with auditory impairments generally will not possess unique needs requiring separation from regular programming (unfortunately, this study found that individuals in integrated settings perform at lower levels in physical fitness than those who are institutionalized). Individuals with visual or orthopedic impairments, as a group, will more frequently have unique needs requiring specially designed programs.

Based on this study, it appears that individuals with orthopedic impairments, in particular, need physical education programs in which physical fitness is given more attention. The need for physical activity is necessary to prevent atrophy, bone deformities, etc., to enhance mobility, and simply to enhance health. Although individuals with orthopedic impairments need physical activity to a greater extent than other persons (based on their relatively low performance scores), they evidently receive less than others. In addition, it appears that in cases where physical education is provided for individuals with orthopedic impairments, insufficient attention is apparently given to the development of physical fitness.

In terms of severity of handicapping condition, the results of this study indicate that partially sighted subjects exceeded the performance of individuals who are blind, and more severely afflicted subjects with cerebral palsy performed less aptly on physical fitness test items than individuals with lesser involvement. No significant differences were generally found between hard of hearing and deaf participants on the Project UNIQUE Physical Fitness test items. In view of these results, type and severity of handicapping condition needs to be considered in physical fitness performance in the case of individuals with visual or orthopedic impairments. Less attention to these factors needs to be given relative to individuals with auditory impairments.

Age as a Factor in Performance

On the basis of the results of this study, it is recommended that age be considered as an influencing factor on the performance of physical fitness test results in the case of normal subjects, auditory impaired subjects, and visually impaired subjects. With the exception of the skinfolds, age did not play as great a role on physical fitness test items in the case of subjects with orthopedic impairments. In the case of skinfold measurements, age should be considered for subjects with orthopedic impairments as well. The results of the study indicate that where age is a factor, performance generally improves with age; although in some cases, girls tended to plateau at about ages 12 to 14. Another consideration is the rate of improvement between boys and girls. Boys tend to increase in their performance from the ages 10 to 17, and their rate of improvement is greater than for girls in certain test items. In regard to skinfolds, it is clear that skinfolds generally increase with age; however, an increase in skinfolds at a particular age does not necessarily indicate a higher percent of body fat.

In view of the results that were attained relative to age influences on physical fitness performance, it is necessary to consider age when developing normative data for tests of physical fitness. In addition, program implementers must consider age in prescribing duration, frequency, and intensity of activity.

In activities where physical fitness performance is a factor, it is necessary to consider the age of participants. In view of the plateau tendency relative to girls, it may be necessary to give greater attention to improving the physical fitness performance of girls starting at age 12.

Sex Difference and Performance

Sex was found to be a significant factor on most physical fitness test items for most subject groups. In the case of normal, auditory impaired, and visually impaired subjects, girls were found to have significantly larger skinfolds than boys and higher sit and reach scores than boys. In other areas of performance, boys generally exceeded the performance of girls. In the case of subjects with orthopedic impairments, fewer significant sex differences were found. Since sex differences in performance do exist, sex differences in performance must be considered in selecting test items for the measurement of physical fitness; in the norms provided for physical fitness tests; and level, duration, and intensity of physical activity in programs. In view of the results of this study, grouping individuals on the basis of sex may be warranted in cases where physical fitness performance is a factor. Sex differences also support the need to individualize and personalize programs.

Physical Fitness and Educational Setting

In this study, individuals who were institutionalized exceeded the performance of those who were non-institutionalized on physical fitness test items where differences existed. Results pertaining to the sensory impaired indicated that subjects from institutionalized settings were generally superior to the non-institutionalized group where significant differences on test items occurred. In regard to individuals with orthopedic impairments, educational environment was not a factor in the performance of the orthopedic subgroups on physical fitness items administered to them. Since more severely involved individuals are, at least theoretically, placed in institutionalized settings, the results of this study are enlightening. Certainly, the finding that individuals in institutions exceeded the performance of individuals who are non-institutionalized cannot be considered acceptable educational performance by non-institutionalized schools and agencies educating individuals with handicapping conditions. Unfortunately, the procedures of the study do not enable the investigators to account for these differences. However, it is suspected that availability of physical education, the emphasis within the physical education programs, intramural and athletic opportunities, and staffing influenced these results. In addition, the results may be due to inappropriate placement. Unfortunately, further study will be needed in order to definitively account for the results. The one implication that appears to be warranted is that more attention should be given to the improvement of physical fitness in non-institutionalized settings.

Individualization

The need for individualization is clearly evident from the results obtained in this study. Individuals with handicapping conditions frequently are below normal performance in physical fitness, perform physical activities in different ways than is characteristic of normal individuals, and exhibit greater variability in performance. The variability in performance of subjects with handicapping conditions is particularly acute in the case of individuals with orthopedic impairments.

The education of individuals with handicapping conditions must be considered on a one-to-one basis. It is not appropriate, for example, to simply adapt a physical fitness test for cerebral palsied individuals and to assume that it will be applicable to all such individuals. In selecting test items, for example, it is necessary to consider the abilities and disabilities of each person. For example, although the grip strength test is a recommended test item, it may be inappropriate for individuals who have difficulties in inhibiting the grasp reflex. Even though the grip strength is a test recommended for use for certain individuals with congenital anomalies, it may be inappropriate as a test in those cases where the individual may not be able to properly grasp the grip dynamometer. Although the softball throw may be a recommended test item for individuals with cerebral palsy, it may be very inappropriate if the participant is not able to release the ball properly.

Recognition of Physical Fitness as an Educational Responsibility

Project UNIQUE results generally show lower levels of physical fitness for individuals with handicapping conditions. This is particularly true in the case of individuals with orthopedic impairments. Although the relatively poor performance of individuals with orthopedic impairments can be documented, the reasons for this result can only be speculated. Although individuals in Project UNIQUE samples were generally receiving physical education, it appears that the physical education that was provided did not include a great deal of attention to the development of physical fitness. It may be that one of the reasons for this was the perception that the development of physical fitness was not the responsibility of the teacher of physical education. This possibility exists even though physical fitness is considered as a part of physical education, and it is accepted that physical fitness development includes development of muscular strength/endurance, flexibility, and cardiorespiratory endurance.

If it is recognized that physical fitness is the responsibility of the physical educator, then physical educators must be prepared to implement such programs. Physical educators know the basic principles of development of physical fitness for normal individuals. However, teachers of physical education are often not prepared to provide the modifications necessary to implement effective programs for the handicapped, particularly for individuals with orthopedic impairments. Space does not permit an exhaustive treatment of this subject here; however, a couple of examples might suffice. First, physical educators need to be able to determine the flexibility potential of individuals who exhibit contractures or be able to implement flexibility programs under medical supervision. Physical educators must be educated so they are able to plan programs which do not overdevelop opposing muscle groups. Thus, for example, physical educators need to realize that the elbow flexors of individuals with cerebral palsy must not be overdeveloped in relationship to the extensors, even though the strength of the elbow flexors may be below that of normal individuals. Implementers of physical education programs must be aware that it is not adequate to simply ask a cerebral palsied individual who is spastic to move as fast as possible, but to realize the effect of such instruction on performance and the need to emphasize controlled, purposeful movement and, at the same time, improve speed of movement.

Another consideration which will enhance the physical fitness of individuals with handicapping conditions is to know the role and responsibility of each member of a multidisciplinary team in the development of physical fitness. In the case of teachers of physical education, it is extremely important to know their role and relationship to physical therapists, occupational therapists, and other individuals who have some indirect or direct responsibility for the development of physical fitness of individuals. Closer cooperation needs to be exhibited between physical educators and medical personnel.

Need for Training Materials

In discussing implications eminating from Project UNIQUE, it has been mentioned that there is a need for individuals to begin programs at the basic level of fitness exhibited by each individual, to select and modify appropriate activities for the development of fitness, to follow and modify principles of physical development, as appropriate, and to know the role and responsibility of individuals involved in physical fitness development of individuals with handicapping conditions. In order to help teachers and other individuals to develop the physical fitness of individuals with handicapping conditions involved in this study, a training manual (appearing as an appendix under separate cover) has been developed by the Project UNIQUE staff. In essence, the training manual provides an overview of physical fitness, principles of development which are recommended for normal populations, a description of handicapping conditions involved in the present study, and how the principles of development should be modified for sensory and/or orthopedically impaired children and youth. It is advised that teachers use this manual in connection with the Project UNIQUE Physical Fitness Test so that they will be better able to provide services necessary to improve the physical fitness of youngsters with handicapping conditions.

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APPENDIX A

CONDITION CODES

CONDITION CODES

Listed below are the categories by which subjects were classified. Testers were instructed to use the major headings to locate the general condition a subject possessed and then to find the specific condition that most accurately identified the condition of the subject. Testers were further instructed to assign only one three-digit condition code for each subject. It was suggested to testers that in the event two or more codes seemed appropriate for a given subject, the subject was probably multiply handicapped and ineligible for the study.

I. NON-IMPAIRED

001 = non-impaired

II. AUDITORY IMPAIRED

010 = auditory - hard of hearing
011 = auditory - deaf

III. VISUALLY IMPAIRED

020 = partially sighted - congenital
021 = partially sighted - onset birth to age 6
022 = partially sighted - onset past age 6
023 = totally blind - congenital
024 = totally blind - onset birth to age 6
025 = totally blind - onset past age 6

IV. ORTHOPEDIC IMPAIRED

ORTHOPEDIC AMPUTEE

For the purpose of this study, an orthopedic amputee was defined as subjects who have a congenital or acquired amputation of a limb or a limb part.

A. ORTHOPEDIC ACQUIRED AMPUTEE

ORTHOPEDIC ACQUIRED AMPUTEE - ONE-ARM INVOLVEMENT

030 = finger hand amputation
031 = below elbow amputation
032 = above elbow amputation
033 = shoulder disarticulation

ORTHOPEDIC ACQUIRED AMPUTEE - TWO-ARM INVOLVEMENT

034 = finger hand/finger hand amputation
035 = finger hand/below elbow amputation
036 = finger hand/above elbow amputation
037 = finger hand/shoulder disarticulation
038 = below elbow/below elbow amputation
039 = below elbow/above elbow amputation
040 = below elbow/shoulder disarticulation

041 = above elbow/above elbow amputation
042 = above elbow/shoulder disarticulation
043 = shoulder/shoulder disarticulation

ORTHOPEDIC ACQUIRED AMPUTEE - ONE-LEG INVOLVEMENT

044 = foot amputation
045 = below knee amputation
046 = above knee amputation
047 = hip disarticulation

ORTHOPEDIC ACQUIRED AMPUTEE - TWO-LEG INVOLVEMENT

048 = foot/foot amputation
049 = foot/below knee amputation
050 = foot/above knee amputation
051 = foot/hip disarticulation
052 = below knee/below knee amputation
053 = below knee/above knee amputation
054 = below knee/hip disarticulation
055 = above knee/above knee amputation
056 = above knee/hip disarticulation
057 = hip/hip disarticulation

ORTHOPEDIC ACQUIRED AMPUTEE - ONE-ARM/ONE-LEG INVOLVEMENT

058 = finger hand/foot amputation
059 = finger hand/below knee amputation
060 = finger hand/above knee amputation
061 = finger hand/hip disarticulation
062 = below elbow/foot amputation
063 = below elbow/below knee amputation
064 = below elbow/above knee amputation
065 = below elbow/hip disarticulation
066 = above elbow/foot amputation
067 = above elbow/below knee amputation
068 = above elbow/above knee amputation
069 = above elbow/hip disarticulation
070 = shoulder/foot amputation
071 = shoulder/below knee amputation
072 = shoulder/above knee amputation
073 = shoulder/shoulder disarticulation

ORTHOPEDIC ACQUIRED AMPUTEE - TRIPLEGIC INVOLVEMENT

074 = 2 legs/right arm involvement
075 = 2 legs/left arm involvement
076 = 2 arms/right leg involvement
077 = 2 arms/left leg involvement

ORTHOPEDIC ACQUIRED AMPUTEE - QUADRIPLEGIC INVOLVEMENT

078 = 4 limb involvement

B. ORTHOPEDIC CONGENITAL AMPUTEE

ORTHOPEDIC CONGENITAL AMPUTEE - ONE-ARM INVOLVEMENT

080 = finger hand amputation
081 = below elbow amputation
082 = above elbow amputation
083 = shoulder disarticulation

ORTHOPEDIC CONGENITAL AMPUTEE - TWO-ARM INVOLVEMENT

084 = finger hand/finger hand amputation
085 = finger hand/below elbow amputation
086 = finger hand/above elbow amputation
087 = finger hand/shoulder disarticulation
088 = below elbow/below elbow amputation
089 = below elbow/above elbow amputation
090 = below elbow/shoulder disarticulation
091 = above elbow/above elbow amputation
092 = above elbow/shoulder disarticulation
093 = shoulder/shoulder disarticulation

ORTHOPEDIC CONGENITAL AMPUTEE - ONE-LEG INVOLVEMENT

094 = foot amputation
095 = below knee amputation
096 = above knee amputation
097 = hip disarticulation

ORTHOPEDIC CONGENITAL AMPUTEE - TWO-LEG INVOLVEMENT

098 = foot/foot amputation
099 = foot/below knee amputation
100 = foot/above knee amputation
101 = foot/hip disarticulation
102 = below knee/below knee amputation
103 = below knee/above knee amputation
104 = below knee/hip disarticulation
105 = above knee/above knee amputation
106 = above knee/hip disarticulation
107 = hip/hip disarticulation

ORTHOPEDIC CONGENITAL AMPUTEE - ONE-ARM/ONE-LEG INVOLVEMENT

108 = finger hand/foot amputation
109 = finger hand/below knee amputation
110 = finger hand/above knee amputation
111 = finger hand/hip disarticulation
112 = below elbow/foot amputation
113 = below elbow/below knee amputation
114 = below elbow/above knee amputation
115 = below elbow/hip disarticulation
116 = above elbow/foot amputation

117 = above elbow/below knee amputation
118 = above elbow/above knee amputation
119 = above elbow/hip disarticulation
120 = shoulder/foot amputation
121 = shoulder/below knee amputation
122 = shoulder/above knee amputation
123 = shoulder/hip disarticulation

ORTHOPEDIC CONGENITAL AMPUTEE - TRIPLEGIC INVOLVEMENT

124 = 2 legs/right arm involvement
125 = 2 legs/left arm involvement
126 = 2 arms/right leg involvement
127 = 2 arms/left leg involvement

ORTHOPEDIC CONGENITAL AMPUTEE - QUADRIPLEGIC INVOLVEMENT

128 = 4 limb involvement

C. ORTHOPEDIC CONGENITAL ANOMALIES

Subjects identified as possessing congenital anomalies were individuals whose extremities were fully or partly present and were deformed.

ORTHOPEDIC CONGENITAL ANOMALIES - ONE-ARM INVOLVEMENT

130 = finger hand involvement
131 = below elbow involvement
132 = above elbow involvement
133 = shoulder site

ORTHOPEDIC CONGENITAL ANOMALIES - TWO-ARM INVOLVEMENT

134 = finger hand/finger hand involvement
135 = finger hand/below elbow involvement
136 = finger hand/above elbow involvement
137 = finger hand/shoulder site
138 = below elbow/below elbow involvement
139 = below elbow/above elbow involvement
140 = below elbow/shoulder site
141 = above elbow/above elbow involvement
142 = above elbow/shoulder site
143 = shoulder site/shoulder site

ORTHOPEDIC CONGENITAL ANOMALIES - ONE-LEG INVOLVEMENT

144 = foot involvement
145 = below knee involvement
146 = above knee involvement
147 = hip site

ORTHOPEDIC CONGENITAL ANOMALIES - TWO-LEG INVOLVEMENT

148 = foot/foot involvement
149 = foot/below knee involvement
150 = foot/above knee involvement
151 = foot/hip site
152 = below knee/below knee involvement
153 = below knee/above knee involvement
154 = below knee/hip site
155 = above knee/above knee involvement
156 = above knee/hip site
157 = hip site/hip site

ORTHOPEDIC CONGENITAL ANOMALIES - ONE-ARM/ONE-LEG INVOLVEMENT

158 = finger hand/foot involvement
159 = finger hand/below knee involvement
160 = finger hand/above knee involvement
161 = finger hand/hip site
162 = below elbow/foot involvement
163 = below elbow/below knee involvement
164 = below elbow/above knee involvement
165 = below elbow/hip site
166 = above elbow/foot involvement
167 = above elbow/below knee involvement
168 = above elbow/above knee involvement
169 = above elbow/hip site
170 = shoulder site/foot involvement
171 = shoulder site/below knee involvement
172 = shoulder site/above knee involvement
173 = shoulder site/shoulder site

ORTHOPEDIC CONGENITAL ANOMALIES - TRIPLEGIC INVOLVEMENT

174 = 2 legs/right arm involvement
175 = 2 legs/left arm involvement
176 = 2 arms/right leg involvement
177 = 2 arms/left leg involvement

ORTHOPEDIC CONGENITAL ANOMALIES - QUADRIPLEGIC INVOLVEMENT

178 = 4 limb involvement

D. ORTHOPEDIC CEREBRAL PALSIED

Cerebral palsy was defined as a disorder characterized by disturbances in voluntary motor functioning resulting from lesions in the brain that affect the motor control centers.

ORTHOPEDIC CEREBRAL PALSIED - SPASTIC

180 = monoplegic - right arm
181 = monoplegic - left arm
182 = monoplegic - right leg
183 = monoplegic - left leg

184 = diplegic - major involvement in lower limbs and minor involvement
in upper limbs
185 = triplegic - right arm, left arm, right leg
186 = triplegic - right arm, right leg, left leg
187 = triplegic - left arm, right leg, left leg
188 = triplegic - right arm, left arm, left leg
189 = hemiplegic - right arm, right leg
190 = hemiplegic - left arm, left leg
191 = paraplegic - right leg, left leg
192 = quadriplegic - all four extremities - partial or complete

ORTHOPEDIC CEREBRAL PALSIED - ATHETOID

200 = monoplegic - right arm
201 = monoplegic - left arm
202 = monoplegic - right leg
203 = monoplegic - left leg
204 = diplegic - major involvement in lower limbs and minor involvement
in upper limbs
205 = triplegic - right arm, left arm, right leg
206 = triplegic - right arm, right leg, left leg
207 = triplegic - left arm, right leg, left leg
208 = triplegic - right arm, left arm, left leg
209 = hemiplegic - right arm, right leg
210 = hemiplegic - left arm, left leg
211 = paraplegic - right leg, left leg
212 = quadriplegic - all four extremities - partial or complete

ORTHOPEDIC CEREBRAL PALSIED - TREMOR

220 = monoplegic - right arm
221 = monoplegic - left arm
222 = monoplegic - right leg
223 = monoplegic - left leg
224 = diplegic - major involvement in lower limbs and minor involvement
in upper limbs
225 = triplegic - right arm, left arm, right leg
226 = triplegic - right arm, right leg, left leg
227 = triplegic - left arm, right leg, left leg
228 = triplegic - right arm, left arm, left leg
229 = hemiplegic - right arm, right leg
230 = hemiplegic - left arm, left leg
231 = paraplegic - right leg, left leg
232 = quadriplegic - all four extremities - partial or complete

ORTHOPEDIC CEREBRAL PALSIED - RIGIDITY

240 = monoplegic - right arm
241 = monoplegic - left arm
242 = monoplegic - right leg
243 = monoplegic - left leg
244 = diplegic - major involvement in lower limbs and minor involvement
in upper limbs

245 = triplegic - right arm, left arm, right leg
246 = triplegic - right arm, right leg, left leg
247 = triplegic - left arm, right leg, left leg
248 = triplegic - right arm, left arm, left leg
249 = hemiplegic - right arm, right leg
250 = hemiplegic - left arm, left leg
251 = paraplegic - right leg, left leg
252 = quadriplegic - all four extremities - partial or complete

ORTHOPEDIC CEREBRAL PALSIED - ATAXIC

260 = monoplegic - right arm
261 = monoplegic - left arm
262 = monoplegic - right leg
263 = monoplegic - left leg
264 = diplegic - major involvement in lower limbs and minor involvement in upper limbs
265 = triplegic - right arm, left arm, right leg
266 = triplegic - right arm, right leg, left leg
267 = triplegic - left arm, right leg, left leg
268 = triplegic - right arm, left arm, left leg
269 = hemiplegic - right arm, right leg
270 = hemiplegic - left arm, left leg
271 = paraplegic - right leg, left leg
272 = quadriplegic - all four extremities - partial or complete

ORTHOPEDIC CEREBRAL PALSIED - MIXED

280 = monoplegic - right arm
281 = monoplegic - left arm
282 = monoplegic - right leg
283 = monoplegic - left leg
284 = diplegic - major involvement in lower limbs and minor involvement in upper limbs
285 = triplegic - right arm, left arm, right leg
286 = triplegic - right arm, right leg, left leg
287 = triplegic - left arm, right leg, left leg
288 = triplegic - right arm, left arm, left leg
289 = hemiplegic - right arm, right leg
290 = hemiplegic - left arm, left leg
291 = paraplegic - right leg, left leg
292 = quadriplegic - all four extremities - partial or complete

E. ORTHOPEDIC SPINAL NEUROMUSCULAR CONDITION

Spinal neuromuscular conditions were acquired or congenital conditions characterized by spinal lesion which directly affected limb functioning.

300 = partial or complete - lesion cite unknown
301 = partial or complete - cervical lesion
302 = partial or complete T_1 to T_5 lesion
303 = partial or complete - T_6 to T_{10} lesion
304 = partial or complete - T_{11} to L_2 lesion
305 = partial or complete - L_3 to below lesion